



# BRIEF COURSE IN PLANE AND SPHERICAL TRIGONOMETRY

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DAVIS AND CHAMBERS'S TRIGONOMETRY

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## PREFACE

The purpose of this book is to provide a concise text for the regular college course in trigonometry. The authors have aimed to present, briefly but clearly, all the topics usually taught in plane and spherical trigonometry. All theorems and formulas for which the student is not likely to have use are carefully omitted. This is especially true in the case of spherical trigonometry.

An attempt has been made to avoid the needlessly long discussions so prevalent in many books. A precise explanation of each topic is given, followed by one or more completely solved illustrations. The authors do not consider it sufficient merely to tell the student how to solve a problem; they believe he should be shown how to do it.

First the trigonometric functions are defined and used for acute angles. Later the definitions are extended to include angles of all magnitudes. This seems to the authors to be the natural method of approach.

A chapter on logarithms is included just before the solution of the right triangle. Enough of the theory of logarithms is introduced to give the proper background for the intelligent use of logarithmic computation.

Computation problems are set up in a manner which saves time and facilitates checking. Each number is ordinarily written but once, even though it is used several times in the computation.

The authors have endeavored to keep a proper balance between numerical trigonometry, which is an end in itself, and analytic trigonometry, which is indispensable to the student in his study of more advanced mathematics. A rather complete treatment of De Moivre's Theorem, trigonometric series, and hyperbolic functions is given. At the discretion of the instructor, the entire



chapter containing these subjects can be omitted without detriment to the remainder of the course.

A concise development of the ordinary formulas of spherical trigonometry is followed by numerous practical and modern terrestrial and astronomical applications.

Because the authors have found the college student to be ignorant of even the elementary facts of astronomy, such as the causes of the seasons and of the phases of the moon, a few items of everyday astronomy have been discussed in the Appendix.

This book is issued with and without tables. For the edition with tables, the authors are indebted to American Book Company for permission to include Crockett's *Logarithmic and Trigonometric Tables*. These tables are also issued in a separate edition.

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# PLANE TRIGONOMETRY

## CHAPTER I

### MEASUREMENT OF ANGLES

1. **Measurement of Angles.** The most familiar system of angle measurement is called the *sexagesimal system*. The principal unit of this system is the *degree* ( $^{\circ}$ ), which is one ninetieth of a right angle. The degree is divided into sixty *minutes* ( $'$ ), and the minute into sixty *seconds* ( $''$ ).

Consider two perpendicular lines meeting at a point  $O$  (Fig. 1). These lines divide the plane into four parts called *quadrants*. The quadrants are numbered I, II, III, and IV, as in Fig. 1.

If  $OP$  coincides with  $OA$  (Fig. 1), the angle between the lines is zero. Now rotate  $OP$  about the fixed point  $O$  in a counterclockwise direction. At any instant the line  $OP$  meets the line  $OA$  in some angle, such as  $AOP'$ . Hence we may consider  $OB$ ,  $OC$ ,  $OD$ , and  $OQ$  as the line  $OP$  rotated through angles of  $90^{\circ}$ ,  $180^{\circ}$ ,  $270^{\circ}$ , and

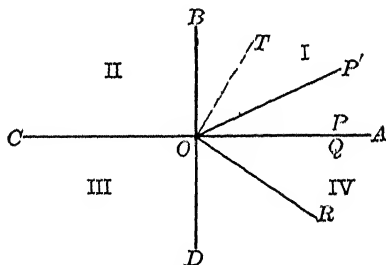


FIG. 1

$360^{\circ}$ , respectively. By rotating the line in this manner we see that we have passed through the four quadrants in order. Also we note that angles from  $0^{\circ}$  to  $90^{\circ}$  lie in the first quadrant, angles from  $90^{\circ}$  to  $180^{\circ}$  lie in the second quadrant, angles from  $180^{\circ}$  to  $270^{\circ}$  lie in the third quadrant, and angles from  $270^{\circ}$  to  $360^{\circ}$  lie in the fourth quadrant. But this rotation may be continued indefinitely. Hence we have, in general, the following, where  $n$  is any positive integer, negative integer, or zero:

Angles from  $n \cdot 360^{\circ} + 0^{\circ}$  to  $n \cdot 360^{\circ} + 90^{\circ}$  are in the first quadrant.

Angles from  $n \cdot 360^{\circ} + 90^{\circ}$  to  $n \cdot 360^{\circ} + 180^{\circ}$  are in the second quadrant.

Angles from  $n \cdot 360^{\circ} + 180^{\circ}$  to  $n \cdot 360^{\circ} + 270^{\circ}$  are in the third quadrant.

Angles from  $n \cdot 360^{\circ} + 270^{\circ}$  to  $n \cdot 360^{\circ} + 360^{\circ}$  are in the fourth quadrant.

If the line  $OP$  is rotated in a clockwise direction, a negative angle is described. Hence the angle  $AOR$  is a negative angle numerically less than  $90^\circ$ . Such an angle lies in the fourth quadrant.

It should be noted that the quadrant to which an angle belongs refers merely to its size and not to its position. For instance, the positive angle  $ROP'$  (Fig. 1) lies in the first quadrant, because it is an acute angle. This is evident if the angle is rotated to the position  $AOT$ . Care must be taken not to confuse this idea with that of negative angles. An angle of  $-30^\circ$ , when placed in proper position, will be a fourth-quadrant angle and not a first-quadrant one, even though it is numerically less than  $90^\circ$ .

It is possible to express any angle, as  $n \cdot 360^\circ + \theta^*$ , where  $\theta$  is a positive angle less than  $360^\circ$ . This value  $\theta$  is called the *principal value* of the angle.

#### EXERCISES

1. Find the principal value of  $436^\circ$ .

SOLUTION.  $436^\circ = 360^\circ + 76^\circ$ . Hence the principal value of  $436^\circ$  is  $76^\circ$ .

2. Find the principal value of  $-462^\circ$ .

SOLUTION.  $-462^\circ = -2 \cdot 360^\circ + 258^\circ$ . Hence the principal value of  $-462^\circ$  is  $258^\circ$ .

3. Find the principal values of the following angles:  $476^\circ$ ,  $520^\circ$ ,  $730^\circ$ ,  $1200^\circ$ ,  $720^\circ$ ,  $672^\circ$ .

4. Find the angle through which the minute hand of a clock passes between 3 o'clock and 6 o'clock. Find the angle traversed by the hour hand.

5. Plot each of the angles in ex. 1 to 4. Determine the quadrant of each and check with the principal values found above.

6. Find the principal values of the following angles:  $-431^\circ 10' 32''$ ,  $-100^\circ$ ,  $694^\circ$ ,  $-80^\circ$ ,  $742^\circ 13'$ ,  $-934^\circ$ ,  $-75^\circ 30' 46''$ ,  $734^\circ 10' 50''$ .

7. Construct a fairly accurate graph locating the following angles:  $30^\circ$ ,  $45^\circ$ ,  $60^\circ$ ,  $120^\circ$ ,  $135^\circ$ ,  $150^\circ$ ,  $210^\circ$ ,  $225^\circ$ ,  $240^\circ$ ,  $300^\circ$ ,  $315^\circ$ ,  $330^\circ$ . These angles are used frequently in the work which is to come, and the student should become familiar with their positions.

**2. The Circular System.** Another system of angular measure used extensively in mathematics is the *circular system*. The unit of measure is called the *radian*.

If a circle is drawn with the center at the vertex of an angle, a *radian* is the angle that subtends an arc equal in length to the radius of the circle.

\*The Greek letter "theta."

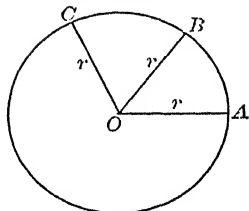


FIG. 2

or

In geometry we learn that two central angles in the same or equal circles are to each other as their subtended arcs. In Fig. 2, let arc  $AB=r$  and arc  $AC=s$ . Then angle  $AOB=1$  radian. If  $\theta$  represents the number of radians in angle  $AOC$ , we have

$$\frac{\theta}{1} = \frac{s}{r} \quad (1)$$

Hence to find the number of radians in an angle, divide the subtended arc by the radius of the arc.

Since the arc subtended by a straight angle ( $180^\circ$ ) is half a circumference, or  $\pi r$ , we have

$$\theta = \frac{s}{r} = \frac{\pi r}{r} = \pi$$

or

$$180^\circ = \pi \text{ radians} \quad (2)$$

Let  $x$  represent the number of degrees in any angle, and let  $\theta$  represent the number of radians in the same angle. Then  $x^\circ = \theta$  radians. Making use of Formula 2, we have

$$\frac{x^\circ}{180^\circ} = \frac{\theta}{\pi} \quad (3)$$

Formulas 1, 2, and 3 are extremely important and should be memorized.

The approximate value of 1 radian is  $57^\circ 17' 44.8''$ .

## EXERCISES

1. Express  $30^\circ$  in radians.

SOLUTION. In Formula 3, let  $x=30^\circ$  and solve for  $\theta$ .

$$\frac{30^\circ}{180^\circ} = \frac{\theta}{\pi}; \quad \theta = \frac{\pi}{6} \text{ radians.}$$

2. Express  $\frac{3}{4}\pi$  radians in degrees.

SOLUTION. In Formula 3, let  $\theta = \frac{3}{4}\pi$  and solve for  $x$ .

$$\frac{x^\circ}{180^\circ} = \frac{\frac{3}{4}\pi}{\pi}; \quad x=135^\circ.$$

3. Express in terms of radians:  $0^\circ, 45^\circ, 60^\circ, 90^\circ, 120^\circ, 135^\circ, 150^\circ, 180^\circ, 210^\circ, 225^\circ, 240^\circ, 270^\circ, 300^\circ, 315^\circ, 330^\circ, 360^\circ$ .

4. Reduce to degrees: (a)  $\frac{\pi}{3}$  radians; (b)  $\frac{\pi}{5}$  radians; (c)  $\frac{\pi}{6}$  radians; (d)  $\frac{8\pi}{5}$  radians.
5. Reduce to radians: (a)  $46^\circ$ ; (b)  $137^\circ$ ; (c)  $214^\circ 30'$ ; (d)  $318^\circ$ .
6. Reduce to degrees, minutes, and seconds: (a) 0.51 radians; (b) 2.2 radians; (c) 3 radians; (d) 5.8 radians. (Use  $\pi=3.14$ .)
7. Find the length of the arc subtended by a central angle of  $63^\circ$  in a circle with a radius of 6 ft.
8. Find the distance traveled by the point of an 8-inch hour hand of a clock between 8.00 and 10.30.
9. Find the radius of the circle in which an arc 5 in. long subtends an angle of  $74^\circ$ .
10. Find the central angle subtended by an 8-inch arc in a circle with a radius of 12 in.
11. Through what angle will a spoke of a wheel 4 ft. in diameter turn in going 100 yd.?
12. The end of a 36-inch pendulum describes an arc of 4 in. Find the angle through which the pendulum swings.
13. Find the arc in ex. 12 if the angle is  $15^\circ$ .
14. Through what angle will a reel 2 ft. in diameter be turned in winding up 30 ft. of garden hose?
15. Through what angle will a pulley wheel 10 in. in diameter turn while 10 ft. of rope pass over it?

## CHAPTER II

### TRIGONOMETRIC FUNCTIONS OF ACUTE ANGLES

**3. Definitions.** *Trigonometry* deals with *angles* and their *trigonometric functions*. The computing of the unknown parts of a triangle from certain previously measured or known parts is still one of the chief uses of elementary trigonometry. Modern trigonometry, however, has a much wider scope. It includes all mathematical investigations by means of the trigonometric functions defined below.

Consider an acute angle, as  $\angle A$  in Fig. 3. From any point  $B$  on one side of the angle drop a perpendicular to the other side, meeting it in  $C$ . In the right triangle thus formed denote by  $a$ ,  $b$ , and  $c$  the sides opposite  $A$ ,  $B$ , and  $C$ , respectively. The six most frequently used *trigonometric functions of the angle  $A$*  are then defined as follows:

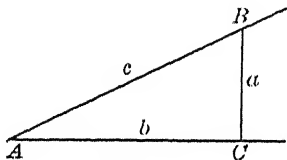


FIG. 3

$$\text{sine of } A \text{ (written } \sin A) = \frac{\text{opposite side}}{\text{hypotenuse}} = \frac{a}{c}$$

$$\text{cosine of } A \text{ (written } \cos A) = \frac{\text{adjacent side}}{\text{hypotenuse}}$$

$$\text{tangent of } A \text{ (written } \tan A) = \frac{\text{opposite side}}{\text{adjacent side}} = \frac{a}{b}$$

$$\text{cotangent of } A \text{ (written } \cot A) = \frac{\text{adjacent side}}{\text{opposite side}} = \frac{b}{a}$$

$$\text{secant of } A \text{ (written } \sec A) = \frac{\text{hypotenuse}}{\text{adjacent side}} = \frac{c}{b}$$


$$\text{cosecant of } A \text{ (written } \csc A) = \frac{\text{hypotenuse}}{\text{opposite side}} = \frac{c}{a}$$

Notice that the functions depend on the magnitude of the angle  $A$  alone, and not on the lengths of the sides of the triangle used in defining them. For instance, in Fig. 4,  $\sin A$  may be



expressed as  $\frac{CB}{AB}$  or as  $\frac{C'B'}{AB'}$ . These two ratios are equal, since corresponding sides of similar triangles are proportional.

**4. The Eight Fundamental Identities.** From the preceding

 definitions it is seen that

$$\cot A = \frac{1}{\tan A} \quad (4)$$

$$\sec A = \frac{1}{\cos A} \quad (5)$$

$$\csc A = \frac{1}{\sin A} \quad (6)$$

FIG. 4

Notice also that  $\frac{\sin A}{\cos A} = \frac{\frac{c}{b}}{\frac{a}{c}} = \frac{a}{c} \cdot \frac{c}{b} = \frac{a}{b} = \tan A$

and that  $\frac{\cos A}{\sin A} = \frac{\frac{b}{a}}{\frac{c}{a}} = \frac{b}{c} = \cot A$

Hence  $\tan A = \frac{\sin A}{\cos A} \quad (7)$

and  $\cot A = \frac{\cos A}{\sin A} \quad (8)$

From Fig. 3,  $a^2 + b^2 = c^2$

Dividing both sides of this equation by  $c^2$ ,  $b^2$ , and  $a^2$  in turn, we get

$$\left(\frac{a}{c}\right)^2 + \left(\frac{b}{c}\right)^2 = 1 \quad \left(\frac{a}{b}\right)^2 + 1 = \left(\frac{c}{b}\right)^2 \quad 1 + \left(\frac{b}{a}\right)^2 = \left(\frac{c}{a}\right)^2$$

By the definitions of Section 1, these are equivalent to the following:

$$\sin^2 A + \cos^2 A = 1^* \quad (9)$$

$$\tan^2 A + 1 = \sec^2 A \quad (10)$$

$$\cot^2 A + 1 = \csc^2 A \quad (11)$$

The eight relations given in Formulas 4-11, connecting the trigonometric functions of an angle, are very important and should be memorized.

\*It is customary to write  $\sin^2 A$  instead of  $(\sin A)^2$ , etc.

5. The Functions of  $(90^\circ - A)$ . From Fig. 3, we have

$$\sin A = \frac{a}{c} = \cos B \quad \tan A = \frac{a}{b} = \cot B \quad \sec A = \frac{c}{b} = \csc B$$

$$\cos A = \frac{b}{c} = \sin B \quad \cot A = \frac{b}{a} = \tan B \quad \csc A = \frac{c}{a} = \sec B$$

Since  $B = (90^\circ - A)$ , we may write these relations as follows:

$$\sin A = \cos (90^\circ - A) \quad \cot A = \tan (90^\circ - A)$$

$$\cos A = \sin (90^\circ - A) \quad \sec A = \csc (90^\circ - A)$$

$$\tan A = \cot (90^\circ - A) \quad \csc A = \sec (90^\circ - A)$$

In other words, *any function of an angle is equal to the co-function\* of its complement.*

6. Functions of  $30^\circ$ ,  $45^\circ$ , and  $60^\circ$ . It is easy to calculate the values of the trigonometric functions of a few special angles by elementary means.

Draw a square  $ACBD$  with sides 1 unit in length (Fig. 5). Draw the diagonal  $AB$ , thus dividing the square into two equal triangles. In triangle  $ABC$ , we have  $A = B = 45^\circ$ ,  $a = b = 1$ , and  $c = \sqrt{2}$ . Hence we may read the trigonometric functions of  $45^\circ$  from triangle  $ABC$ .

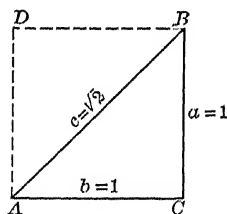


FIG. 5

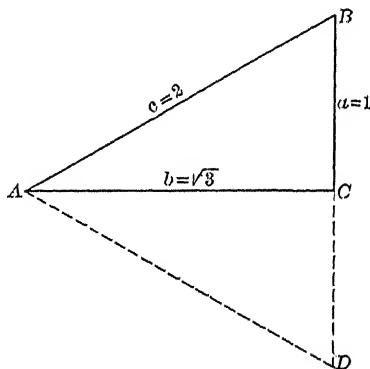


FIG. 6

Draw an equilateral triangle  $ABD$  with sides 2 units in length (Fig. 6). Draw the altitude  $AC$ . Then in right triangle  $ABC$ ,  $A = 30^\circ$ ,  $B = 60^\circ$ ,  $a = 1$ ,  $b = \sqrt{3}$ , and  $c = 2$ . Hence we may use angles  $A$  and  $B$  to find the functions of  $30^\circ$  and  $60^\circ$ .

\*The co-function of  $\sin A$  is  $\cos A$ ; that of  $\cos A$  is  $\sin A$ , etc.

The values of the six trigonometric functions of  $30^\circ$ ,  $45^\circ$ , and  $60^\circ$  thus obtained are shown in the table on page 15. Since they are frequently used in the work to follow, the student should become familiar with their derivation and should memorize their values.

**7. Functions of  $0^\circ$  and  $90^\circ$ .** Let  $\theta$  (Fig. 7) be an acute angle. With  $A$  as center and radius  $c$ , draw the arc  $OP$ . From the point  $B$  drop a perpendicular to  $AE$ , meeting it in  $C$ . Then, in

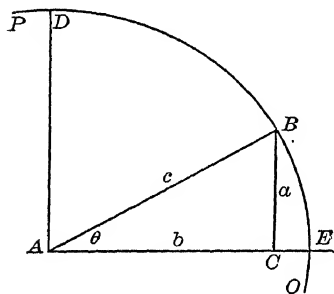


FIG. 7

right triangle  $ABC$ , we have

$$\sin \theta = \frac{a}{c} \quad \cot \theta = \frac{b}{a}$$

$$\cos \theta = \frac{b}{c} \quad \sec \theta = \frac{c}{b}$$

$$\tan \theta = \frac{a}{b} \quad \csc \theta = \frac{c}{a}$$

As  $B \rightarrow E$  (read " $B$  approaches  $E$  as a limit"),  $\theta \rightarrow 0$ ,  $a \rightarrow 0$ , and  $b \rightarrow c$ .

Hence

$$\sin 0^\circ = \lim_{a \rightarrow 0} \frac{a}{c} = 0$$

$$\cot 0^\circ = \lim_{a \rightarrow 0} \frac{b}{a} = \infty$$

$$\cos 0^\circ = \lim_{b \rightarrow c} \frac{b}{c} = 1$$

$$\sec 0^\circ = \lim_{b \rightarrow c} \frac{c}{b} = 1$$

$$\tan 0^\circ = \lim_{a \rightarrow 0} \frac{a}{b} = 0$$

$$\csc 0^\circ = \lim_{a \rightarrow 0} \frac{c}{a} = \infty$$

The symbol  $\lim_{a \rightarrow 0}$  is read "the limit, as  $a$  approaches 0, of  $\dots$ ."

$\cot 0^\circ$  and  $\csc 0^\circ$  have no definite values, since the denominators of  $\cot \theta$  and  $\csc \theta$  approach zero in the limit, and division by zero is not permissible. The symbol  $\infty$  (read "infinity") means that  $\cot \theta$  and  $\csc \theta$  become indefinitely large as  $\theta \rightarrow 0$ .

In Fig. 7, if we let  $B \rightarrow D$ , we have  $\theta \rightarrow 90^\circ$ ,  $a \rightarrow c$ , and  $b \rightarrow 0$ . Hence

$$\sin 90^\circ = \lim_{a \rightarrow c} \frac{a}{c} = 1$$

$$\cot 90^\circ = \lim_{b \rightarrow 0} \frac{b}{a} = 0$$

$$\cos 90^\circ = \lim_{b \rightarrow 0} \frac{b}{c} = 0$$

$$\sec 90^\circ = \lim_{b \rightarrow 0} \frac{c}{b} = \infty$$

$$\tan 90^\circ = \lim_{b \rightarrow 0} \frac{a}{b} = \infty$$

$$\csc 90^\circ = \lim_{a \rightarrow c} \frac{c}{a} = 1$$

The following table summarizes the work of the last two sections:

| Angle | sin                   | cos                   | tan                  | cot                   | sec                   | csc                   |
|-------|-----------------------|-----------------------|----------------------|-----------------------|-----------------------|-----------------------|
| 0°    | 0                     | 1                     | 0                    | ∞                     | 1                     | ∞                     |
| 30°   | $\frac{1}{2}$         | $\frac{1}{2}\sqrt{3}$ | $\frac{1}{\sqrt{3}}$ | $\sqrt{3}$            | $\frac{2}{3}\sqrt{3}$ | 2                     |
| 45°   | $\frac{1}{2}\sqrt{2}$ | $\frac{1}{2}\sqrt{2}$ | 1                    | 1                     | $\sqrt{2}$            | $\sqrt{2}$            |
| 60°   | $\frac{1}{2}\sqrt{3}$ | $\frac{1}{2}$         | $\sqrt{3}$           | $\frac{1}{3}\sqrt{3}$ | 2                     | $\frac{2}{3}\sqrt{3}$ |
| 90°   | 1                     | 0                     | ∞                    | 0                     | ∞                     | 1                     |

## EXERCISES

1. Express the sine, cosine, tangent, and cotangent of 30°, 45°, and 60° in decimal form. Verify your work by comparison with the table of natural functions found in the table of logarithms.

2. Verify the values of the functions of 90° by letting  $A=0^\circ$  in the formulas of Section 3.

Solve the following right triangles for the unknown parts:

3.  $A=30^\circ$ ,  $b=15$

SOLUTION.  $\tan A = \frac{a}{b}$ ;  $\frac{1}{3}\sqrt{3} = \frac{a}{15}$

$$\therefore a = 5\sqrt{3}$$

$$\sec A = \frac{c}{b}$$
;  $\frac{2}{3}\sqrt{3} = \frac{c}{15}$

$$\therefore c = 10\sqrt{3}$$

$$\text{Area} = K = \frac{1}{2}ab = 75\sqrt{3}$$

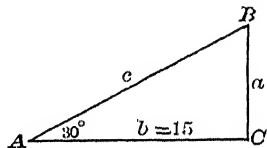


FIG. 8

4.  $A=60^\circ$ ,  $c=10$

7.  $\sec A = \frac{2}{3}$ ,  $c=5$

10.  $\cos A = \frac{1}{2}$ ,  $c=2$

5.  $B=45^\circ$ ,  $a=14$

8.  $\tan A = 1$ ,  $c=8$

11.  $\csc B = \frac{1}{2}$ ,  $a=4$

6.  $\sin A = \frac{1}{3}$ ,  $a=12$

9.  $\cot B = \frac{2}{3}$ ,  $b=1.6$

12.  $a=6$ ,  $c=12$

13. The line joining the top of a tree with a point on the ground 100 ft. from the foot of the tree makes an angle of 30° with the ground. How high is the tree?

14. In a right triangle,  $A = 30^\circ$  and  $a = 12$  in. Find the altitude on side  $c$ .

**8. Some Important Limits.** Let  $\theta$  (Fig. 9) be an acute angle. With the vertex  $O$  as center and radius  $r$ , draw its subtended arc  $AB$ . Draw  $BC$  and  $AD$  perpendicular to  $OA$ . It is clear that

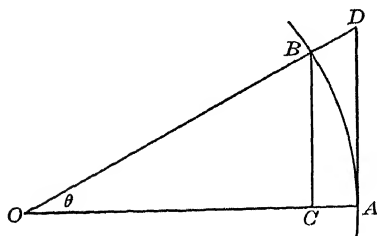


FIG. 9

$$CB < AB < AD$$

Divide by the radius  $r = OA = OB$ :

$$\frac{CB}{OB} < \frac{AB}{r} < \frac{AD}{OA}$$

That is,  $\sin \theta < \theta < \tan \theta$  (i) where  $\theta$  is measured in radians.

Divide (i) by  $\sin \theta$ :

$$1 < \frac{\theta}{\sin \theta} < \frac{1}{\cos \theta}$$

Now let  $\theta \rightarrow 0$ . Since  $\cos 0 = 1$ , we have

$$\lim_{\theta \rightarrow 0} \frac{\theta}{\sin \theta} = 1 \quad (12)$$

Let us next divide the inequality (i) by  $\tan \theta$ . Then

$$\cos \theta < \frac{\theta}{\tan \theta} < 1$$

Since  $\cos 0 = 1$ , we have

$$\lim_{\theta \rightarrow 0} \frac{\theta}{\tan \theta} = 1 \quad (13)$$

For very small angles,  $\sin \theta$ ,  $\tan \theta$ , and  $\theta$  (measured in radians) are nearly equal. For example,

| $\theta$ | $\sin \theta$        | $\theta$ in radians  | $\tan \theta$        |
|----------|----------------------|----------------------|----------------------|
| 1"       | 0.000004848136811076 | 0.000004848136811095 | 0.000004848136811152 |
| 1'       | 0.0002908882045      | 0.0002908882086      | 0.0002908882168      |
| 1°       | 0.0174524064         | 0.0174532925         | 0.0174550649         |

**9. Identities.** An equation that is true for all values of the letters involved is called an *identity*.

Thus,  $(x+a)^2 = x^2 + 2ax + a^2$  is an algebraic identity, and  $\sin^2 A + \cos^2 A = 1$  is a trigonometric identity.

An equation that is true only for certain values of the letters involved is called an *equation of condition* or simply an *equation*.

Thus,  $2x+3=5$  is an algebraic equation that is true only for  $x=1$ ; and  $\sin A = \sqrt{3} \cos A$  is a trigonometric equation that is true only for certain values of  $A$ , including  $A = 60^\circ$ .

In verifying the fundamental identities (Section 4), the definitions of the trigonometric functions were used to reduce the verification to algebraic processes. In the following exercises, the definitions should not be used, since the chief purpose of this section is to familiarize the student with the eight fundamental identities and with trigonometric processes in general.

*Illustration 1.* Verify the identity  $\tan A \sin A + \cos A = \sec A$ .

SOLUTION.  $\frac{\sin A}{\cos A} \sin A + \cos A = \sec A$  By (7)

That is,  $\frac{\sin^2 A + \cos^2 A}{\cos A} = \sec A$ , or  $\frac{1}{\cos A} = \sec A$  By (9)

This is true, by (5). Hence the identity is verified.

Notice that the general method is to assume the truth of the equality and, by use of one or more of the eight fundamental identities, to reduce it to an evident equality; or, if the given expression is not a true identity, to reduce it to an evident inequality, or equation of condition.

*Illustration 2.* Investigate  $\sin A \cot A - 3 \sec A = 2 \cos A$ .

SOLUTION.  $\sin A \frac{\cos A}{\sin A} - 3 \sec A = 2 \cos A$

$\cos A - 3 \sec A = 2 \cos A$ , or  $-3 \sec A = \cos A$

That is,  $\frac{-3}{\cos A} = \cos A$ , or  $-3 = \cos^2 A$  By (5)

This is an evident impossibility; hence the given relation is not true.

*Illustration 3.* Verify the identity  $\sec^4 \theta - \tan^4 \theta = 1 + 2 \tan^2 \theta$ .

SOLUTION.  $(\sec^2 \theta - \tan^2 \theta)(\sec^2 \theta + \tan^2 \theta) = 1 + 2 \tan^2 \theta$

$\sec^2 \theta + \tan^2 \theta = 1 + 2 \tan^2 \theta$

By (10)

$\sec^2 \theta = 1 + \tan^2 \theta$

This is an evident identity.

In case no simpler method of verification is apparent, replace all trigonometric functions involved by their values in terms of the sine and cosine of the same angle, and simplify.

*Illustration 4.* Express each of the trigonometric functions of  $A$  in terms of the cosine of  $A$ .

SOLUTION

$\sin A$

$\cot A = \frac{1}{\tan A} = \frac{\cos A}{\sqrt{1 - \cos^2 A}}$

$\cos A = \cos A$

$\sec A = \frac{1}{\cos A}$

$\tan A = \frac{\sin A}{\cos A} = \frac{\sqrt{1 - \cos^2 A}}{\cos A}$

$\csc A = \frac{1}{\sin A}$

## EXERCISES

Prove the following identities:

1.  $\sec^2 A - \sec^2 A \sin^2 A = 1$ .
2.  $\csc^2 A (1 - \cos^2 A) = 1$ .
3.  $\tan A + \cot A = \sec A \csc A$ .
4.  $\sin^2 A (1 + \cot^2 A) = 1$ .
5.  $\frac{\sin^2 A \sec^2 A + 1}{1 + \tan^2 A} = 1$ .
6.  $\sec^2 A + \csc^2 A = 2 + \sec^2 A \csc^2 A (\sin^4 A + \cos^4 A)$ .
7.  $\cos^2 A = \frac{1}{1 + \tan^2 A}$ .
17.  $\frac{1 + \tan^2 A}{1 + \cot^2 A} = \tan^2 A$ .
8.  $\frac{\tan^2 B - 1}{\cot^2 B - 1} = 1 - \sec^2 B$ .
18.  $\frac{2 - \cos x}{\cos x} = 2 \sec x - 1$ .
9.  $\cos A - \sec A = -\tan A \sin A$ .
19.  $\sec^2 A - \csc^2 A = \tan^2 A - \cot^2 A$ .
10.  $\frac{1 + \cos x}{1 - \cos x} = \frac{\sec x + 1}{\sec x - 1}$ .
20.  $\frac{1}{1 + \sin x} + \frac{1}{1 - \sin x} = 2 \sec^2 x$ .
11.  $\frac{\sec^2 y + \csc^2 y}{\sec^2 y - \csc^2 y} = \frac{\tan^2 y + 1}{\tan^2 y - 1}$ .
21.  $\frac{\cot A \cos A}{\cot A - \cos A} = \frac{\cos A}{1 - \sin A}$ .
12.  $\tan^4 x + \tan^2 x = \sec^4 x - \sec^2 x$ .
22.  $\frac{\cot A + 1}{\sin A + \cos A} = \csc A$ .
13.  $\frac{\sin x + 2 \sin x \cos x}{2 + \cos x - 2 \sin^2 x} = \tan x$ .
23.  $\frac{\sec x + 1}{\tan x} = \frac{\tan x}{\sec x - 1}$ .
14.  $\sin z (\cot z + 1) = \sin z + \cos z$ .
24.  $\frac{1}{\sec y + \tan y} = \sec y - \tan y$ .
15.  $\sin^4 x - \cos^4 x = \sin^2 x - \cos^2 x$ .
25.  $\sec^4 z - 1 = 2 \tan^2 z + \tan^4 z$ .
16.  $\frac{\sin \theta + \cot \theta}{\sin \theta - \cot \theta} = \frac{\tan^2 \theta + \sec \theta}{\tan^2 \theta - \sec \theta}$ .
26.  $\sin^2 A \cos^2 A + \cos^4 A = 1 - \sin^4 A$ .
27.  $\sin^4 x - \cos^4 x = 1 - 2 \cos^2 x = 2 \sin^2 x - 1$ .

Investigate the following:

28.  $\sin^2 A + 1 = \cos^2 A$ .
29.  $\tan^2 x - 3 = \sec^2 x$ .
30.  $\sin^2 A - \sin A = 0$ .
31.  $\sin A \sec A \cot A = 1$ .
32.  $\sec^2 A + \tan^2 A = 1$ .
33.  $\sec^2 y + \csc^2 y = \sec^2 y \csc^2 y$ .
34.  $\sin A + \cos A = 4$ .
35.  $\tan A + \cot A = 1$ .
36.  $(\sin x + \cos x)^2 + (\sin x - \cos x)^2 = 2$ .
37.  $(\sqrt{1 - \sin A} + \sqrt{1 + \sin A})^2 = 2(1 + \cos A)$ .
38.  $\frac{\tan x + \tan y}{\cot x + \cot y} = \tan x \tan y$ .
39.  $\frac{\cot x + \tan y}{\tan x + \cot y} = \cot x \tan y$ .
40.  $\frac{1 + \cos x}{1 - \cos x} - \frac{1 - \cos x}{1 + \cos x} = 4 \cot x \csc x$ .
41.  $\frac{1 + \sin y}{1 - \sin y} - \frac{1 - \sin y}{1 + \sin y} = 4 \tan y \sec y$ .
42. If  $x = r \cos t$  and  $y = r \sin t$ , show that  $x^2 + y^2 = r^2$ .
43. If  $x = a \cos t$  and  $y = b \sin t$ , show that  $\left(\frac{x}{a}\right)^2 + \left(\frac{y}{b}\right)^2 = 1$ .
44. Express all functions of  $x$  in terms of  $\sin x$ ; of  $\tan x$ ; of  $\cot x$ ; of  $\sec x$ ; of  $\csc x$ .

## CHAPTER III

### LOGARITHMS

**10. Introduction.** Logarithms are used to shorten numerical computations. The theory of logarithms belongs to algebra; but since logarithms are used extensively in numerical trigonometry, enough of their theory is given here to enable the student to use them understandingly.

If three numbers,  $N$ ,  $a$ , and  $n$ , satisfy the equation  $N=a^n$ , then  $n$  is said to be the *logarithm* of  $N$  to the *base*  $a$ . If, without changing  $a$ , we give to  $N$  and  $n$  all possible values consistent with the above equation, the values of  $n$  thus obtained form a *system of logarithms* with the base  $a$ .

*The logarithm of a number is the exponent to which the base must be raised to produce the number.*

That is, if  $N=a^n$ , then  $\log_a N=n$ . The symbol  $\log_a N$  is read "the logarithm of  $N$  to the base  $a$ ."

Since  $10^3=1000$ ,  $\log_{10} 1000=3$ , and so on.

Although any positive real number except 0 and 1 may be taken as the base of a system of logarithms, only two systems are in general use. One is the system of *common logarithms*, with base 10, used in computation. The other is the *natural system*, with base  $e=2.718281828459\cdots$ , used in theoretical work.

**11. Some Fundamental Theorems.** The properties of logarithms which make them so useful in shortening numerical computation are developed in the following theorems:

I. *The logarithm of 1 is 0.*

PROOF.  $a^0=1$ ; hence  $\log_a 1=0$ .

II. *The logarithm of the base is 1.*

PROOF.  $a^1=a$ ; hence  $\log_a a=1$ .

III. *The logarithm of a product is equal to the sum of the logarithms of the factors.* That is,

$$\log_a MN = \log_a M + \log_a N$$

PROOF. Let  $\log_a M=m$  and  $\log_a N=n$ . Then, by definition,  $M=a^m$  and  $N=a^n$ . Multiplying, we have

$$MN = a^{m+n}, \text{ or } \log_a MN = m + n = \log_a M + \log_a N$$



IV. *The logarithm of a quotient is equal to the logarithm of the numerator minus the logarithm of the denominator.* That is,

$$\log_a \frac{M}{N} = \log_a M - \log_a N$$

PROOF. Let  $\log_a M = m$  and  $\log_a N = n$ . Then  $M = a^m$  and  $N = a^n$ . Dividing, we have

$$\frac{M}{N} = a^m \quad \text{or} \quad \log_a \frac{M}{N} = m - n = \log_a M - \log_a N$$

V. *The logarithm of a power of a number is equal to the exponent times the logarithm of the number.* That is,

$$\log_a N^p = p \log_a N$$

PROOF. Let  $\log_a N = n$ ; then  $N = a^n$ . Raising both sides to power  $p$ , we have  $N^p = a^{np}$ , or  $\log_a N^p = np = p \log_a N$ .

VI. *The logarithm of a root of a number is equal to the logarithm of the number divided by the index of the root.* That is,

$$\log_a \sqrt[r]{N} = \frac{\log_a N}{r}$$

PROOF. Let  $\log_a N = n$ ; then  $N = a^n$ . Extracting the  $r$ th root of each side gives  $\sqrt[r]{N} = a^{\frac{n}{r}}$ , or  $\log_a \sqrt[r]{N} = \frac{n}{r} = \frac{\log_a N}{r}$ .

**12. The Common System of Logarithms.** Nearly all logarithms used in this text are to base 10. When the base is omitted, it is understood to be 10. Thus,  $\log N$  means  $\log_{10} N$ .

The logarithms of powers of 10, to base 10, may be arranged as follows:

|                |                             |                  |                  |
|----------------|-----------------------------|------------------|------------------|
| $10^4 = 10000$ | $\therefore \log 10000 = 4$ | $10^0 = 1$       | $\log 1 = 0$     |
| $10^3 = 1000$  | $\therefore \log 1000 = 3$  | $10^{-1} = .1$   | $\log .1 = -1$   |
| $10^2 = 100$   | $\therefore \log 100 = 2$   | $10^{-2} = .01$  | $\log .01$       |
| $10^1 = 10$    | $\therefore \log 10 = 1$    | $10^{-3} = .001$ | $\log .001 = -3$ |

It is thus seen that the logarithm of a number between

|                |                            |              |                             |
|----------------|----------------------------|--------------|-----------------------------|
| 1000 and 10000 | is $3 + \text{a fraction}$ | .1 and 1     | is $-1 + \text{a fraction}$ |
| 100 and 1000   | is $2 + \text{a fraction}$ | .01 and .1   | is $-2 + \text{a fraction}$ |
| 10 and 100     | is $1 + \text{a fraction}$ | .001 and .01 | is $-3 + \text{a fraction}$ |
| 1 and 10       | is $0 + \text{a fraction}$ |              |                             |

A logarithm is composed of two parts—an integer (positive, negative, or zero), called the *characteristic*, and a positive fraction, called the *mantissa*.

Consider a set of numbers such as the following:

$$\begin{array}{lll} 240 = 100(2.4) & 2.4 = 1(2.4) & .024 = .01(2.4) \\ 24 & 10(2.4) & .24 = .1(2.4) \end{array}$$

It follows from Fundamental Theorem III that

$$\begin{aligned} \log 240 &= \log 100 + \log 2.4 = 2 + \log 2.4 \\ \log 24 &= \log 10 + \log 2.4 = 1 + \log 2.4 \\ \log 2.4 &= \log 1 + \log 2.4 = 0 + \log 2.4 \\ \log .24 &= \log .1 + \log 2.4 = -1 + \log 2.4 \\ \log .024 &= \log .01 + \log 2.4 = -2 + \log 2.4 \end{aligned}$$

**13. To find the Logarithm of a Number in the Tables.** Only the mantissa is given in a table of logarithms. The characteristic is supplied, being determined by the position of the decimal point.

In the table, opposite 240 we find the mantissa 38021. Hence

$$\begin{array}{ll} 240 \dots \log^* = 2.38021 & .24 \dots \log = 9.38021 - 10 \\ 24 \dots \log = 1.38021 & .024 \dots \log = 8.38021 - 10 \\ 2.4 \dots \log = 0.38021 & \end{array}$$

It is customary to write 9-10, 8-10, etc. instead of -1, -2, etc. when dealing with negative characteristics.

**RULE.** *The characteristic of a number greater than 1 is positive, and is one less than the number of figures to the left of the decimal point.*

*The characteristic of a positive number less than 1 is negative, and is numerically one more than the number of zeros between the decimal point and the first significant figure.*

The logarithm of a negative number is imaginary and is not used in computation.

In an ordinary five-place table, the first three figures of a number are in the first column and the fourth figure is at the top of the page.

The student should verify the following by reference to a five-place table:

$$\begin{array}{ll} 1642 \dots \log = 3.21537 & 2 \dots \log = 0.30103 \\ 20.04 \dots \log = 1.30190 & .0081 \dots \log = 7.90849 - 10 \\ .2576 \dots \log = 9.41095 - 10 & 96.42 \dots \log = 1.98417 \end{array}$$

The mantissa of a number given in the table is only an approximation, correct to the nearest figure in the fifth place.

\*It is advisable to write the symbol log after the number rather than before it, for reasons that will appear later.

The mantissa of a number consisting of 5 figures is found by a process called *interpolation*. For example,  $\log 24.876$  is found thus:

$$\begin{array}{r} 24.88 \dots \log = 1.39585 \\ 24.87 \dots \log = 1.39568 \\ \hline \text{Difference} = .00017 \end{array}$$

The difference between two consecutive mantissas in the table is called the *tabular difference*. It is 17 in this case.

Since  $24.876 = 24.87 + .6$  of .01 (the difference between 24.87 and 24.88),  $\log 24.876 = \log 24.87 + \frac{6}{10}$  of 17, which is 10. (The actual number is 10.2, but we take the nearest integer, 10.) Hence  $\log 24.876 = 1.39578$ .

In some tables, little auxiliary tables are given in the space headed "proportional parts" or "P. P." at the right of or at the foot of each page. With such tables interpolation is done as follows: In looking for  $\log 24.876$ , we find that the tabular difference is 17. At the left of the little table, under 17, we find 6, the fifth figure of 24.876. To the right of it is the number 10.2, of which the nearest integer, 10, is to be added to  $\log 24.87$  to give  $\log 24.876$ .

The student should verify the following logarithms:

$$\begin{array}{ll} 27.643 \dots \log = 1.44159 & 575,680 \dots \log = 5.76018 \\ .036427 \dots \log = 8.56142 - 10 & .62492 \dots \log = 9.79582 - 10 \end{array}$$

**14. To Find the Number Corresponding to a Given Logarithm.** Suppose it is desired to find  $N$ , where  $\log N = 2.68422$ . Since only the mantissa is contained in the tables, look for 68 in the column headed 0. Then look in the body of the table, between 68 and 69, for 422. It is found in the column headed 3, row 483. Hence  $N = 483.3$ . The decimal point is located by means of the characteristic, 2, which is 1 less than the number of figures to the left of the decimal point.

Now suppose  $\log N = 2.68456$ . Since 68456 is not in the table, take the nearest mantissa before 68456, namely, 68449. Corresponding to this is 4836, the first four figures of  $N$ . Subtracting 68449 from the next mantissa, 68458, gives a tabular difference of 9. Subtracting 68449 from the given 68456 gives a difference of 7. Hence  $\frac{7}{9}$ , or .8 (to the nearest tenth), must be the fifth figure, giving 48368. Since the characteristic is 2,  $N = 483.68$ . This is called the *antilogarithm* of 2.68456.

The little tables of proportional parts are an aid in this case also. When the tabular difference of 9 and the difference of 7 are found, look in the right-hand column of the 9 table for the number nearest 7, namely, 7.2. On the left is 8, the fifth figure of  $N$ .

The student should supply the missing numbers\*:

$$\begin{array}{ll} \dots\dots \log = 1.66143 & \dots\dots \log = 9.89880-10 \\ \dots\dots \log = 0.55091 & \dots\dots \log = 2.18162 \end{array}$$

**15. Multiplication.** By Fundamental Theorem III,

$$\log MN = \log M + \log N$$

Hence, to multiply numbers, add their logarithms and look up the antilogarithm of the sum.

*Illustration 1.* Calculate  $x = 4 \times 16$ .

$$\begin{array}{ll} \text{SOLUTION. } \log x = \log 4 + \log 16 & 4 \dots \log = 0.60206 \\ & 16 \dots \log = 1.20412 \\ & x = 64 \dots \log = 1.80618 \end{array}$$

In the above computation, the logarithms of 4 and 16 were found from the table and added. Then the number 64, corresponding to the sum of the logarithms, was found in the table. It is well to underline the answer.

It is, of course, a waste of time to use logarithms in multiplying two such numbers as 4 and 16. But notice the following:

*Illustration 2.* Calculate the product (23.786)(.00694)(9834.8).

$$\begin{array}{ll} \text{SOLUTION.} & 23.786 \dots \log = 1.37632 \\ & .00694 \dots \log = 7.84136-10 \\ & 9834.8 \dots \log = 3.99276 \\ & \underline{1623.4 \dots \log = 3.21044} \end{array}$$

The sum of the logarithms, 13.21044-10, may be written 3.21044.

Since the logarithms in the tables are correct only to the nearest fifth place, it follows that calculation by means of logarithms is only an approximation. The exact product in the above illustration is 1623.478036432.

#### EXERCISES

Calculate by means of logarithms:

- |                           |  |
|---------------------------|--|
| 1. (25) (5)               | 4. (2500) (400)                        |
| 2. (694.4) (7953) (.0063) | 5. (6789.2) (.0049853) (2.2222)        |
| 3. (23,234) (.0032324)    | 6. (74.475) (.10092) (3.0007) (6676.9) |

**16. Division.** By Fundamental Theorem IV,

$$\log \frac{M}{N} = \log M - \log N$$

Hence, to divide  $M$  by  $N$ , subtract the logarithm of  $N$  from the logarithm of  $M$  and look up the antilogarithm.

\*The answers are, respectively, 45.86, 3.5556, 0.79214, and 151.92.

*Illustration 1.* Divide 34 by 5.

$$\begin{array}{rcl} \text{SOLUTION.} & 34 \dots\dots \log & = 1.53148 \\ & 5 \dots\dots \log & = \underline{0.69897} \\ & \underline{6.8} \dots\dots \log & = \underline{0.83251} \end{array}$$

*Illustration 2.* Calculate  $684.72 \div 24.876$ .

$$\begin{array}{rcl} \text{SOLUTION.} & 684.72 \dots\dots \log & = 2.83551 \\ & 24.876 \dots\dots \log & = \underline{1.39578} \\ & \underline{27.525} \dots\dots \log & = \underline{1.43973} \end{array}$$

*Illustration 3.* Divide 7.8246 by 248.76.

$$\begin{array}{rcl} \text{SOLUTION.} & 7.8246 \dots\dots \log & = 10.89346 - 10 \\ & 248.76 \dots\dots \log & = \underline{2.39578} \\ & \underline{.031454} \dots\dots \log & = \underline{8.49768 - 10} \end{array}$$

Notice that in order to facilitate the subtraction in the last illustration, the characteristic 0 was written  $10-10$ . If the characteristic in question had been 1, it would have been written  $11-10$ .

#### EXERCISES

Calculate by means of logarithms:

- |                    |                             |                           |
|--------------------|-----------------------------|---------------------------|
| 1. $64 \div 16$    | 3. $1897.3 \div 1492.5$     | 5. $5342.8 \div 9787.2$   |
| 2. $1728 \div 144$ | 4. $0.98734 \div 0.0044444$ | 6. $0.098765 \div 56.765$ |

17. **Involution.** By Fundamental Theorem V,

$$\log N^p = p \log N$$

Hence, to raise a number to a power, multiply the logarithm of the number by the exponent and look up the corresponding number.

*Illustration 1.* Cube 12.

$$\begin{array}{rcl} \text{SOLUTION} & & \\ 12 \dots \log & = & 1.07918 \\ & & \underline{3} \\ \underline{1728} \dots \log & = & \underline{3.23754} \end{array}$$

*Illustration 2.* Evaluate  $(.02493)^7$ .

$$\begin{array}{rcl} \text{SOLUTION} & & \\ .02493 \dots\dots\dots \log & = & 8.39672 - 10 \\ & & \underline{7} \\ \underline{.000000000059847} \dots \log & = & \underline{58.77704 - 70} \end{array}$$

Notice that the characteristic in the second illustration is  $58-70=-12$ , hence eleven zeros must follow the decimal point.

#### EXERCISES

Calculate by means of logarithms:

- |          |                 |                 |                    |
|----------|-----------------|-----------------|--------------------|
| 1. $2^5$ | 2. $(1.7321)^2$ | 3. $(59.724)^3$ | 4. $(0.0093546)^4$ |
|----------|-----------------|-----------------|--------------------|

18. **Evolution.** By Fundamental Theorem VI,

$$\log \sqrt[r]{N} = \frac{\log N}{r}$$

Hence, to extract a root of a number, divide the logarithm of the number by the index of the root and look up the antilogarithm.

*Illustration 1.* Extract the square root of 2.

$$\begin{array}{rcl} \text{SOLUTION.} & 2^{\frac{1}{2}} \dots \log & = \frac{1}{2}(0.30103) \\ & \underline{1.4142} \dots \log & = 0.15052 \end{array}$$

*Illustration 2.* Extract the seventh root of 0.0058436.

$$\begin{array}{rcl} \text{SOLUTION.} & 0.0058436^{\frac{1}{7}} \log & = \frac{1}{7}(67.76668-70) \\ & \underline{0.47968} \dots \log & = 9.68095-10 \end{array}$$

Notice that the characteristic,  $-3$ , of the original number in the second illustration is written  $67-70$  instead of  $7-10$  in order to facilitate division by 7. If we had been extracting the fifth root of the same number, we would have written the characteristic  $47-50$ .

#### EXERCISES

Extract the roots as indicated:

- |                        |                               |
|------------------------|-------------------------------|
| 1. Square root of 144  | 4. Cube root of 0.79797       |
| 2. Square root of 5    | 5. Seventh root of 14,926,000 |
| 3. Cube root of 17.563 | 6. Thirteenth root of 23      |

19. **The Cologarithm.**  $\log \frac{1}{N} = \log 1 - \log N = 0 - \log N$ . The  $\log \frac{1}{N} = 0 - \log N$  is called the *cologarithm* of  $N$  (abbreviated *colog*  $N$ , or simply *col*  $N$ ).

A quotient  $\frac{M}{N}$  can be expressed as a product  $M \cdot \frac{1}{N}$ . Hence, in calculating  $\frac{M}{N}$  by logarithms, we may, if we wish, add *colog*  $N$  to  $\log M$  instead of subtracting  $\log N$  from  $\log M$ .

In order to obtain the cologarithm of a number, subtract the logarithm of the number from  $10-10$ , which is one way of writing 0. For example,

$$\begin{array}{rcl} & 10.00000-10 & \\ 24.67 \dots \log & = \underline{1.39217} & \\ 24.67 \dots \text{col} & = 8.60783-10 & \end{array} \qquad \begin{array}{rcl} & 10.00000-10 & \\ 0.0467 \dots \log & = \underline{8.66932-10} & \\ 0.0467 \dots \text{col} & = 1.33068 & \end{array}$$

With a little practice, the subtraction can be performed mentally and the cologarithm written directly. Beginning at the left, subtract each integer from 9, except the last, which must be subtracted from 10.

Cologarithms are of no advantage if one wishes merely to divide one number by another. But they are of great advantage in a problem such as the following:

*Illustration.* Evaluate  $\frac{(604.73) (0.7289)}{(67.428) (0.004296)}$ .

*SOLUTION.*

|               |       |     |                |
|---------------|-------|-----|----------------|
| 604.73        | ..... | log | = 2.78156      |
| 0.7289        | ....  | log | = 9.86267 - 10 |
| 67.428        | ..... | col | = 8.17116 - 10 |
| 0.004296      | ..    | col | = 2.36694      |
| <u>1521.7</u> | ..... | log | = 3.18233      |

#### EXERCISES

Evaluate, using cologarithms of numbers in the denominator:

1.  $\frac{(604.72) (0.9098)}{(76.43)}$
2.  $\frac{(0.0033233) (0.092837)}{(0.59832) (0.078642)}$
3.  $\frac{(90000000) (0.000987) (34.432)}{(84) (0.000002) (39.374) (24350)}$

**20. Negative Numbers.** The logarithm of a negative number is imaginary and is of no use in computation. If negative factors occur in an expression to be evaluated, perform the computation as though all factors were positive. The answer will be positive or negative, according as an even number or an odd number of negative factors occurs in the original expression. In practice, it is often of value to designate negative factors by writing  $n$  after the logarithm or cologarithm of each.

*Illustration.* Evaluate  $\frac{(24.67) (-6.04) (-0.302)}{(3.46) (-0.00172)}$ .

*SOLUTION.*

|                |       |     |                             |
|----------------|-------|-----|-----------------------------|
| 24.67          | ..... | log | = 1.39217                   |
| -6.04          | ..... | log | = 0.78104 <sub>n</sub>      |
| -0.302         | ....  | log | = 9.48001 - 10 <sub>n</sub> |
| 3.46           | ..... | col | = 9.46092 - 10              |
| -0.00172       | ....  | col | = 2.76447 <sub>n</sub>      |
| <u>-7561.5</u> | ..... | log | = 3.87861 <sub>n</sub>      |

**21. Logarithms of Trigonometric Functions.** Suppose it were desired to calculate  $x = 28.429 \sin 62^\circ 15'$ .

From the table of natural functions we find

$$x = (28.429) (0.88499)$$

Performing the indicated multiplication by means of logarithms, we have

$$\begin{array}{r} 28.429 \dots \log = 1.45376 \\ 0.88499 \dots \log = \underline{9.94694 - 10} \\ x = 25.159 \dots \log = 1.40070 \end{array}$$

The process of looking up the natural sine of the angle and the logarithm of the sine is tedious and is made unnecessary by the preparation of tables of *Logarithms of the Trigonometric Functions*. Using such a table, we write:

$$\begin{array}{r} 28.429 \dots \log = 1.45376 \\ 62^\circ 15' \dots \log \sin = \underline{9.94694 - 10} \\ x = 25.159 \dots \log = 1.40070 \end{array}$$

In the tables of logarithms of trigonometric functions,  $-10$  is understood to follow every logarithm in which the mantissa is preceded by 6, 7, 8, or 9.

Interpolation is done in a manner similar to that used in the logarithms of ordinary numbers. Tabular differences are sometimes given in columns under  $d$  in the tables. Care must be taken to see if the correction is to be *added* or *subtracted* to give the desired logarithm.

*Illustration 1.* Find  $\log \tan 25^\circ 13' 48''$ .

SOLUTION

$$\begin{array}{r} 25^\circ 14' \dots \log \tan = 9.67327 - 10 \\ 25^\circ 13' \dots \log \tan = \underline{9.67295 - 10} \\ \text{Difference} = .00032 \end{array} \qquad \begin{array}{r} 25^\circ 13' \dots \log \tan = 9.67295 - 10 \\ \frac{4}{3} \times .00032 = .00026 \\ 25^\circ 13' 48'' \dots \log \tan = \underline{9.67321 - 10} \end{array}$$

The correction for  $48''$  is  $\frac{4}{3}$  of .00032, or .00026. This correction is to be *added*, since  $\log \tan 25^\circ 14'$  is larger than  $\log \tan 25^\circ 13'$ . This correction could also be obtained from a column of proportional parts sometimes given at the right of or at the bottom of the page.

*Illustration 2.* Find  $\log \cos 56^\circ 14' 17''$ .

SOLUTION

$$\begin{array}{r} 56^\circ 13' \dots \log \cos = 9.74512 - 10 \\ 56^\circ 14' \dots \log \cos = \underline{9.74493 - 10} \\ \text{Difference} = .00019 \end{array} \qquad \begin{array}{r} 56^\circ 14' \dots \log \cos = 9.74493 - 10 \\ \frac{1}{3} \times .00019 = .00005 \\ 56^\circ 14' 17'' \dots \log \cos = \underline{9.74488 - 10} \end{array}$$

The tabular difference is 19 and the correction is 5. Since the logarithm of the cosine *decreases* as the angle increases, this correction is to be *subtracted*.



Notice that the logarithms of the secant and the cosecant are not given in the tables. These are omitted because they are

so easily obtained. Since  $\sec \theta = \frac{1}{\cos \theta}$  and  $\csc \theta = \frac{1}{\sin \theta}$ ,  
 $\log \sec \theta = \text{col } \cos \theta$  and  $\log \csc \theta = \text{col } \sin \theta$ .

*Illustration 3.* Calculate  $a = b \sin A \csc B$ , where  $b = 24.685$ ,  $A = 61^\circ 14' 15''$ , and  $B = 25^\circ 14' 30''$ .

SOLUTION.  $b = 24.685 \dots \dots \log = 1.39244$   
 $A = 61^\circ 14' 15'' \dots \log \sin = 9.94281 - 10$   
 $B = 25^\circ 14' 30'' \dots \text{col } \sin = 0.37014$   
 $a = \underline{50.744} \dots \dots \log = 1.70539$

*Illustration 4.* Find  $x$  when  $\log \tan x = 9.84728 - 10$ .

SOLUTION. The angle corresponding to the logarithm just before 9.84728 in the L. Tan. column is  $35^\circ 07'$ . The tabular difference is 27. Hence the correction is  $\frac{1}{3}$  of  $60''$ , or  $38''$ , and we have

$$\underline{35^\circ 07' 38''} \dots \log \tan = 9.84728 - 10$$

#### EXERCISES

1. Evaluate  $\frac{(63.842)\sqrt[3]{0.064}}{(2.4678)^3\sqrt{1.08}}$  by means of logarithms.

SUGGESTION. Arrange the work thus:

|        |       |                   |   |
|--------|-------|-------------------|---|
| 63.842 | ...   | log               | = |
| 0.064  | ...   | $\frac{1}{3}$ log | = |
| 2.4678 | ...   | $\frac{3}{1}$ col | = |
| 1.08   | ...   | $\frac{1}{2}$ col | = |
| .....  | ..... | log               | = |

Evaluate the following by means of logarithms:

- |  |  |
|--|--|
| 2. $\sqrt{10} \sqrt[3]{100} \sqrt[4]{1000}$        | 4. $\sqrt{0.1} \sqrt[3]{0.01} \sqrt[4]{0.001}$                             |
| 3. $\frac{(72.452)^2 \sqrt{0.096872}}{(6.6666)^3}$ | 5. $\frac{(576.42)^{\frac{1}{2}} \sqrt{82.223}}{\sqrt{0.0245} (94.452)^2}$ |

$$6. \sqrt{(78.234)^2 + (32.323)^2}$$

SOLUTION.

|        |       |     |               |         |
|--------|-------|-----|---------------|---------|
| 78.234 | ..... | log | =             | 1.89339 |
|        |       |     | $\frac{2}{2}$ |         |
| 6120.4 | ...   | log | =             | 3.78678 |
|        |       |     | $\frac{2}{2}$ |         |
| 32.323 | ..... | log | =             | 1.50951 |
|        |       |     | $\frac{2}{2}$ |         |
| 1044.8 | ...   | log | =             | 3.01902 |
| 7165.2 | ...   | log | =             | 3.85523 |
|        |       |     | $\frac{1}{2}$ |         |
| 84.648 | ...   | log | =             | 1.92762 |

7.  $\sqrt{(0.0098986)^2 + (1.0008)^2}$

8.  $[(65.657)^2 + 34.439]^{\frac{1}{2}}$

9.  $\sqrt{(43.438)^2 - (32.425)^2}$

SUGGESTION. Factor the expression under the radical:

$$\sqrt{(43.438)^2 - (32.425)^2} = \sqrt{(43.438 + 32.425)(43.438 - 32.425)} = \sqrt{(75.863)(11.013)}.$$

10.  $\sqrt{(64.3)^2 - (0.234)^2}$

11.  $\frac{(0.7143)(1.3333)(2.8)}{(2.6667)}$

12. Find the volume  $V = \frac{4}{3}\pi r^3$  of a sphere of radius  $r = 16.25$  in.

13. How many tons per acre does an inch of rainfall represent? (A cubic foot of water weighs 62.425 pounds.)

14. Calculate  $A = \frac{1}{2}r^2(\theta - \sin \theta)$  when  $r = 20.86$  and  $\theta = 86^\circ$ . (The first  $\theta$  must be expressed in radians.)

15. Evaluate  $\frac{24.675 \sin 36^\circ 17' 15''}{\sin 42^\circ 18' 20''}$ .

16.  $\sin A = \frac{434.22 \sin 76^\circ 18' 22''}{528.75}$ . Find  $A$ .

17.  $\tan x = \frac{246.72 \tan 16^\circ 18' 42''}{178.42 \cos 76^\circ 18' 16''}$ . Find  $x$ .

18. Change  $78^\circ 15'$  to radians.

SOLUTION. From (3),  $\theta = \frac{\pi x}{180} = \frac{(3.1416)(78.25)}{180}$ .

$$3.1416 \dots \log = 0.49715$$

$$78.25 \dots \log = 1.89348$$

$$180 \dots \dots \log = \underline{7.74473 - 10}$$

$$\underline{1.3657} \dots \log = 0.13536$$

$$\text{Hence } 78^\circ 15' = 1.3657 \text{ radians.}$$

19. Change to radians: (a)  $125^\circ 34' 30''$ ; (b)  $1^\circ$ ; (c)  $1'$ ; (d)  $1''$ .

20. Change to degrees, minutes, and seconds: (a) 2.4385 radians; (b) 0.0456 radians; (c) 1 radian.

## CHAPTER IV

### SOLUTION OF THE RIGHT TRIANGLE

**22. Solution of the Right Triangle.** We learn from plane geometry how to construct a triangle when three parts, at least one of which is a side, are given. Trigonometry provides methods for computing the values of the parts not given. Such a process is called *solving the triangle*.

If one angle is  $90^\circ$ , only two other parts, at least one of which is a side, are necessary to determine the triangle. In order to solve a right triangle, draw the figure and underline the given parts. Then set up a relation involving the two known parts and *one* unknown part, and solve for the unknown part.

*Illustration 1.* Solve the right triangle:  $a = 16.427$ ,  $c = 38.876$ .

**SOLUTION.**  $\sin A = \frac{a}{c}$  and  $b^2 = c^2 - a^2 = (c+a)(c-a)$ . For a check, from

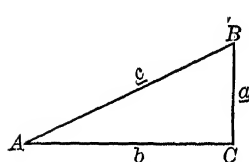


FIG. 10

$\tan A = \frac{a}{b}$  get  $b = a \cot A$ . The check formula should involve the two calculated parts. The work should be arranged as follows:

$$\sin A = \frac{a}{c} \quad B = 90^\circ - A$$

$$b = \sqrt{(c+a)(c-a)}$$

**CHECK.**  $b = a \cot A$

|                                |                        |                         |
|--------------------------------|------------------------|-------------------------|
| $\underline{a = 16.427}$ ..... | log = 1.21556          | ..... log = 1.21556     |
| $\underline{c = 38.876}$ ..... | log = 1.58968          |                         |
| $c + a = 55.303$ .....         | log = 1.74275          |                         |
| $c - a = 22.449$ .....         | log = 1.35120          |                         |
| $A = 24^\circ 59' 44''$ .....  | log sin = 9.62588 - 10 | ..... log cot = 0.33142 |
| $B = 65^\circ 00' 16''$ .....  |                        |                         |
|                                |                        | 3.09395                 |
| $b = 35.235$ .....             | log = 1.54698          | ..... log = 1.54698     |

It is *important* that the work should be arranged as shown above.

When the sides are given to four or five significant figures and the angles are measured or are to be calculated to the nearest second, the computation should be done by logarithms, as in the illustration on page 30.

*Illustration 2.* Solve the right triangle:  $a=16$ ,  $c=38$ .

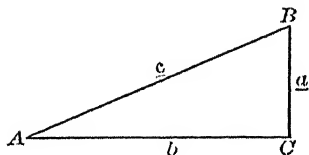


FIG. 11

SOLUTION

$$\sin A = \frac{a}{c}$$

$$B = 90^\circ - A$$

$$b = \sqrt{(c+a)(c-a)}$$

$$\sin A = \frac{16}{38} = 0.42105$$

$$b = \sqrt{(38+16)(38-16)} = \sqrt{54 \cdot 22} = 6\sqrt{33} = 6 \times 5.7445$$

$$\text{Hence } A = 24^\circ 54', B = 65^\circ 06', b = 34.467.$$

The number of digits retained in the calculated value of  $b$  should be in accordance with the accuracy of the given parts. If  $a$  and  $c$  are assumed to be obtained from rough measurements in which only the integral parts were retained, we should not expect the decimal part of  $b$  to be correct. In such a case we should write  $b=34$  and  $A=25^\circ$ . In certain applications, such rough approximations are all that is desired. In other instances, even a five-place table of logarithms does not give results of sufficient accuracy and a seven-place table must be used.

*Illustration 3.* Solve the right triangle:

$$A=76^\circ 52' 06'', a=167.42.$$

SOLUTION.  $c = \frac{a}{\sin A} \quad b = a \cot A$   
 $B = 90^\circ - A = 13^\circ 07' 54''$

CHECK.  $b = c \cos A$

|                       |                       |                      |
|-----------------------|-----------------------|----------------------|
| $a=167.42$            | .....log=12.22381-10  | .....log=2.22381     |
| $A=76^\circ 52' 06''$ | ..log sin= 9.98849-10 | ..log cot=9.36789-10 |
| $c=171.92$            | .....log= 2.23532     | .....log=2.23532     |
| $b=39.057$            | .....log=1.59170      | .....log=1.59171     |

The slight discrepancy between  $\log b$ , as obtained from the direct calculation and from the check formula, is due to the fact that the logarithms in a table are only approximations correct to the nearest figure in the last place. When two or more logarithms are combined in a calculation, such slight discrepancies may become aggravated until the last place is incorrect. If the values of  $\log b$  above had differed by as much as two units in the last place, we should have suspected an error in the work.

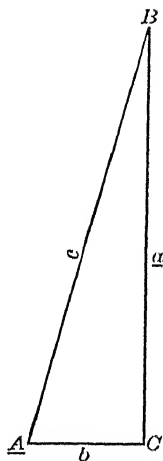


FIG. 12

*Illustration 4.* Solve the right triangle:  $a=42.786$ ,  $b=67.428$ .

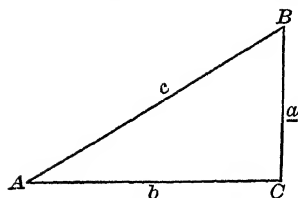


FIG. 13

**SOLUTION.** Since the formula  $c^2=a^2+b^2$  is not adapted to logarithmic computation, it is advisable in this case to make use of an angle already found in calculating  $c$ . The work should be arranged as follows:

$$\tan A = \frac{a}{b} \qquad c = \frac{a}{\sin A}$$

$$B = 90^\circ - A$$

**CHECK.**  $c = \frac{b}{\cos A}$

$$\begin{array}{llll} a=42.786 \dots \dots \log = 11.63130-10 \dots \log = 11.63130-10 & & & \\ b=67.428 \dots \dots \log = 1.82884 & & \log = 11.82884-10 & \\ A=32^\circ 23' 49'' \dots \log \tan = 9.80246-10 \dots \log \sin = 9.72899-10 \dots \log \cos = 9.92652-10 & & & \\ c=79.857 \dots \dots & & \dots \log = 1.90231 & \dots \log = 1.90232 \end{array}$$

## EXERCISES

Solve the following right triangles:

- |                                       |                                       |
|---------------------------------------|---------------------------------------|
| 1. $A=72^\circ 13'$ , $c=429.3$       | 5. $A=34^\circ 10'$ , $a=67.341$      |
| 2. $A=24^\circ 10' 18''$ , $b=103.42$ | 6. $A=47^\circ 34' 42''$ , $c=9.903$  |
| 3. $A=47^\circ 18' 45''$ , $c=56.656$ | 7. $a=57.419$ , $b=86.235$            |
| 4. $a=304.51$ , $B=63^\circ 12'$      | 8. $a=811.75$ , $B=35^\circ 43' 56''$ |

**23. Small Angles.** Interpolation for seconds in the log-sin and log-tan tables is unreliable when the angle is small (less than  $2^\circ$ ). This is due to the fact that the tabular difference is large. Since small angles are frequently desired to a high degree of accuracy, the following method of procedure is given:

Let  $\log \frac{\sin \theta}{\theta} = S$  and  $\log \frac{\tan \theta}{\theta} = T$ , where  $\theta$  is measured in seconds.

Then  $\log \sin \theta - \log \theta = S$  and  $\log \tan \theta - \log \theta = T$

That is,

$$\log \sin \theta = \log \theta + S \qquad (14)$$

$$\log \tan \theta = \log \theta + T \qquad (15)$$

The values of  $S$  and  $T$  for small angles can be found in most tables. There is a  $-10$  understood to follow each.

*Illustration 1.* Find  $\log \tan \theta$  when  $\theta = 0^\circ 21' 17''$ .

**SOLUTION.**  $\theta = 1277'' \dots \log = 3.10619$

$$T = \frac{4.68558-10}{\log \tan \theta = 7.79177-10}$$

*Illustration 2.* Find  $\theta$  when  $\log \sin \theta = 7.70964 - 10$ .

*SOLUTION.* From the regular table  $\theta$  is found to be between  $0^\circ 17'$  and  $0^\circ 18'$ ; hence  $S = 4.68557 - 10$ . Since  $\log \theta = \log \sin \theta - S$ , we have:

$$\begin{aligned}\log \sin \theta &= 7.70964 - 10 \\ S &= 4.68557 - 10 \\ \theta &= \underline{1057''} \dots \log = 3.02407 \dots \quad \theta = 0^\circ 17' 37''\end{aligned}$$

Accurate computation cannot be carried out by means of the regular tables of logarithms when it is necessary to use interpolation for the logarithm of the cosine or of the cotangent of an angle between  $88^\circ$  and  $90^\circ$ . In such cases, since  $\cos \theta = \sin (90^\circ - \theta)$  and  $\cot \theta = \tan (90^\circ - \theta)$ , the  $S$  and  $T$  tables may be employed.

*Illustration 3.* Find  $\log \cos \theta$  when  $\theta = 89^\circ 07' 40''$ .

#### SOLUTION

$$\begin{aligned}90^\circ - \theta &= 0^\circ 52' 20'' = 3140'' & \log 3140 &= 3.49693 \\ \log \sin 0^\circ 52' 20'' &= \log \cos 89^\circ 07' 40'' & S &= 4.68556 - 10 \\ & & \log \cos \theta &= 8.18249 - 10\end{aligned}$$

*Illustration 4.* Find  $\theta$  when  $\log \cot \theta = 8.36472 - 10$ .

*SOLUTION.* From the regular table,  $(90^\circ - \theta)$  is seen to be between  $1^\circ 19'$  and  $1^\circ 20'$ ; hence  $T = 4.68565 - 10$ .

Then  $\log (90^\circ - \theta) = \log \tan (90^\circ - \theta) - T$ .

$$\begin{aligned}\log \tan (90^\circ - \theta) &= 8.36472 - 10 \\ T &= 4.68565 - 10 \\ (90^\circ - \theta) &= \underline{4776''} \dots \log = 3.67907\end{aligned}$$

Hence  $(90^\circ - \theta) = 1^\circ 19' 36''$ , and  $\theta = 88^\circ 40' 24''$ .

#### EXERCISES

1. Find  $\log \sin \theta$  and  $\log \tan \theta$  when  $\theta = 0^\circ 06' 38''$ .
2. Find  $\log \sin 1^\circ 26' 18''$ .
3. Find  $\log \cos \theta$  and  $\log \cot \theta$  when  $\theta = 88^\circ 56' 14''$ .
4. Find  $\log \tan 23''$ .
5. If  $\log \sin \theta = 8.08672 - 10$ , find  $\theta$ .
6. Find  $\theta$  if  $\log \tan \theta = 6.40762 - 10$ .
7. Find  $\theta$  if  $\log \cot \theta = 7.63902 - 10$ .
8. Find  $\theta$  if  $\log \cos \theta = 8.30786 - 10$ .

Solve the following right triangles:

9.  $b = 476.14$ ,  $A = 1^\circ 30' 06.5''$
10.  $c = 20.375$ ,  $A = 89^\circ 24' 42''$
11.  $a = 0.077628$ ,  $b = 5.8026$
12.  $a = 78233$ ,  $A = 0^\circ 08' 26''$

**24. Applications.** The angle between the lines joining the extremities of a distant object with the point of observation is called the *angle subtended* by the object.

In Fig. 14, if the observer is at  $O$ , the line  $AB$  subtends the angle  $x$ .

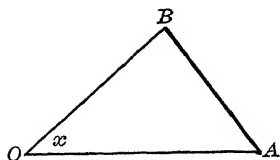


FIG. 14

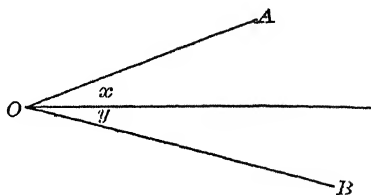


FIG. 15

The acute angle which the line joining a distant point with the point of observation makes with the horizontal plane is called the *angle of elevation* of the distant point if such point is above the observer, and the *angle of depression* if the point is below the observer. For example, if the observer is at  $O$  (Fig. 15),  $x$  is the angle of elevation of  $A$  and  $y$  is the angle of depression of  $B$ .

In an application it is seldom necessary to find all the unknown parts.

## EXERCISES

1. A man 6 ft. tall standing on the bank of a river subtends an angle of  $1^{\circ} 19'$  as observed from the opposite bank. How wide is the river?
2. A tree standing on level ground casts a shadow 137.5 ft. long when the angle of elevation of the sun is  $22^{\circ} 30'$ . How high is the tree?
3. When a man 5 ft. 10 in. tall casts a shadow 10 ft. 5 in. long, what is the angle of elevation of the sun?
4. In order to calculate the distance between two points,  $A$  and  $C$ , on opposite sides of a river, a distance  $CB=150$  ft. is measured perpendicular to  $AC$ . The angle  $CBA$  is then observed to be  $76^{\circ} 15'$ . Find the distance  $AC$ .
5. A flagpole stands on top of a building. From a point 100 ft. from the point directly under the pole, the angles of elevation of the top and the bottom of the pole are  $21^{\circ} 48'$  and  $16^{\circ} 42'$ , respectively. Find the length of the pole.
6. A boy flying a kite lets out 250 ft. of cord. If the angle of elevation of the kite is  $65^{\circ}$ , how high is it above the level of the ground?
7. If, on looking toward the kite in ex. 6, the ground had a downward slope of  $17^{\circ}$ , how high would the kite be?

8. The angle of depression of a boat observed from the top of a lighthouse 80 ft. high is  $2\frac{1}{2}^\circ$ . How far is the boat from the foot of the lighthouse?

9. Two motor boats start from the base of a cliff that is 512 ft. high and run directly out from it. After a time their angles of depression, as observed from the top of the cliff, directly above the starting point, are  $2^\circ 45'$  and  $3^\circ 15'$ . How far apart are the boats?

10. On a certain day the sun is observed to subtend an angle of  $0^\circ 32' 10''$ . If you know that the diameter of the sun is 866,500 mi., how far away do you calculate it to be?

11. A 30-foot ladder leans against a wall. The foot of the ladder is 10 ft. from the wall. How high up is the top of the ladder on the wall and what is its angle of elevation?

12. The peak of a roof is 7 ft. higher than the eaves, and the slope of the rafters is  $32^\circ$ . How far is it across the gable end and how long are the rafters?

13. A tree stands on the bank of a stream which is 32 ft. wide. It breaks off at such a place that its top just touches the opposite bank and its slope is  $36^\circ$ . How tall was the tree before it broke and how high up did it break?

14. A tank is built in the form of an inverted cone surmounted by a cylinder. The altitude of the cylinder is 35 ft. and that of the cone is 15 ft. The vertical angle of the cone is  $140^\circ$ . Find the total area of the tank.

15. From a position 180 ft. above the surface of a lake, the angle of elevation of a mountain top is  $22^\circ 30'$ , and the angle of depression of its reflection in the lake is  $31^\circ 45'$ . Find the height of the mountain above the surface of the lake.

16. A ship sails  $E 13^\circ N$  at a speed of 35 knots. Find the speed of the ship east; also find its speed north.

17. A vessel is bound for a port that is 196 mi. to the north and 78 mi. to the east of the present position. What course must be steered and how long will it take if the average speed of the vessel is 15 knots?

18. If the radius of a circle is 15 ft., what is the size of the arc included between two parallel chords, on the same side of the center, whose distances from the center are 8 ft. and 12 ft., respectively?



## CHAPTER V

### TRIGONOMETRIC FUNCTIONS OF ANY ANGLE

**25. Definitions.** The six trigonometric functions have been defined (Section 3) for positive acute angles only. These definitions will now be extended to positive and negative angles of any magnitude.

Let two perpendicular *axes*,  $X'X$  (the  $X$ -axis) and  $Y'Y$  (the

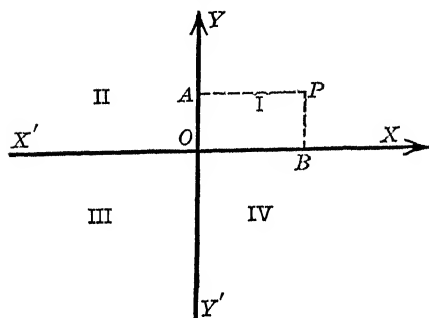


FIG. 16

$Y$ -axis), intersect in an origin,  $O$ , as in Fig. 16. These form the familiar set of *coördinate axes* used in elementary algebra. The perpendicular distance  $AP$  from the  $Y$ -axis to any point  $P$  in the plane is called the *abscissa* of  $P$ . The perpendicular distance  $BP$  from the  $X$ -axis to  $P$  is called the *ordinate* of  $P$ . The ab-

scissa and the ordinate together form the *coördinates* of  $P$ .

We agree to call the abscissa of  $P$  *positive* or *negative* according as  $P$  is to the *right* or to the *left* of the  $Y$ -axis; and to call the ordinate of  $P$  *positive* or *negative* according as  $P$  is *above* or *below* the  $X$ -axis. With these conventions, a point in the plane is uniquely determined by its *coördinates*.

The *coördinate axes* divide the plane into four *quadrants*, as noted in Section 1. The abscissa is positive in the first and fourth quadrants and negative in the second and third. The ordinate is positive in the first and second quadrants and negative in the third and fourth.

Given an angle  $\theta$  of any magnitude. Place it in its normal position (see Section 1) with vertex at  $O$  and one side along  $OX$ , as in Fig. 17(a), page 37. The other side will then fall in one of the four quadrants.\*

\*The special cases in which the second side falls along the boundary between two quadrants are considered separately. See Sections 7 and 27.

Let  $P$  be any point other than  $O$  on the second side of  $\theta$ . Let  $x$  and  $y$  represent the coördinates of  $P$ , and  $r$  the distance  $OP$ . The distance  $r$  is considered positive in each of the four quadrants. We define:

$$\sin \theta = \frac{\text{ordinate}}{\text{distance}}$$

$$\cos \theta = \frac{\text{abscissa}}{\text{distance}} = \frac{x}{r}$$

$$\tan \theta = \frac{\text{ordinate}}{\text{abscissa}} = \frac{y}{x}$$

$$\cot \theta = \frac{\text{abscissa}}{\text{ordinate}} = \frac{x}{y}$$

$$\sec \theta = \frac{\text{distance}}{\text{abscissa}} = \frac{r}{x}$$

$$\csc \theta = \frac{\text{distance}}{\text{ordinate}} = \frac{r}{y}$$

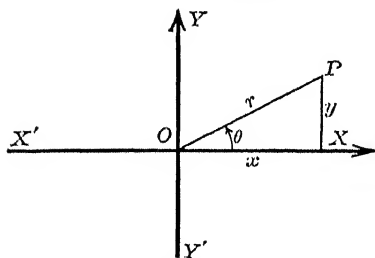


FIG. 17(a)

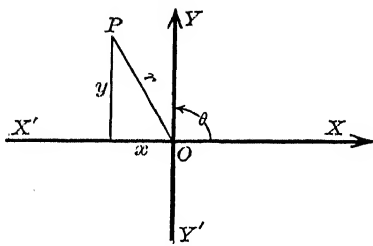


FIG. 17(b)

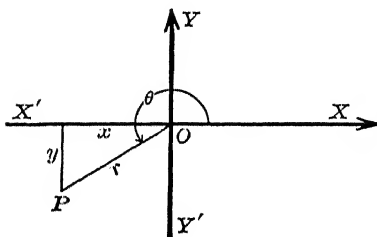


FIG. 17(c)

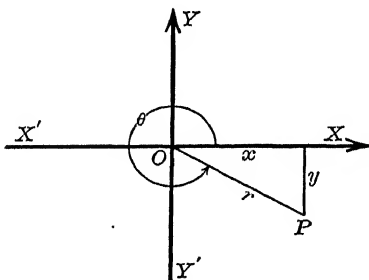


FIG. 17(d)

Notice that these definitions are consistent with those for acute angles given in Section 3, since the two sets are equivalent when  $\theta$  is a first-quadrant angle.

By referring to Fig. 17, the important table of signs on page 38 can be compiled. For example, in the third quadrant, where both  $x$  and  $y$  are negative,

$$\sin \theta = \frac{y}{r} \text{ is negative,} \quad \cos \theta = \frac{x}{r} \text{ is negative,}$$

$$\tan \theta = \frac{y}{x} \text{ is positive, etc.}$$

| Quadrant | Sine<br>and<br>Cosecant | Cosine<br>and<br>Secant | Tangent<br>and<br>Cotangent |
|----------|-------------------------|-------------------------|-----------------------------|
| I        | +                       | +                       | +                           |
| II       | +                       | -                       | -                           |
| III      | -                       | -                       | +                           |
| IV       | -                       | +                       | -                           |

*Illustration 1.* Locate the point  $(-2, 3)$  and find the functions of the angle formed by joining it to the origin.

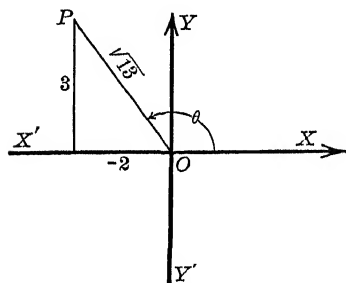


FIG. 18

*SOLUTION.*  $r = \sqrt{13}$  (Fig. 18).  
Hence the values of the functions are:

$$\begin{aligned}\sin \theta &= -\frac{3}{\sqrt{13}} & \cot \theta &= -\frac{2}{3} \\ \cos \theta &= -\frac{2}{\sqrt{13}} & \sec \theta &= -\frac{\sqrt{13}}{2} \\ \tan \theta &= \frac{3}{2} & \csc \theta &= \frac{\sqrt{13}}{3}\end{aligned}$$

To find the value of  $\theta$ , notice that  $\tan \theta = -1.50000$ . From a table of natural functions you see that the first-quadrant angle with tangent 1.5 is  $56^\circ 18' 36''$ . This is evidently the angle  $X'O'P$ . Hence the desired angle,  $\theta$ , is  $180^\circ - 56^\circ 18' 36''$ , or  $123^\circ 41' 24''$ .

*Illustration 2.* Given  $\sin \theta = -\frac{1}{3}$ . Construct  $\theta$  and find all the functions of  $\theta$  in each of the possible quadrants.

*SOLUTION.* There are two possibilities, since the sine is negative in both the third and the fourth quadrant. The values of the functions in each case, as read from Fig. 19, are:

| III                                  | IV                                   |
|--------------------------------------|--------------------------------------|
| $\sin \theta = -\frac{1}{3}$         | $\sin \theta = -\frac{1}{3}$         |
| $\cos \theta = -\frac{2}{3}\sqrt{2}$ | $\cos \theta = \frac{2}{3}\sqrt{2}$  |
| $\tan \theta = \frac{1}{2\sqrt{2}}$  | $\tan \theta = -\frac{1}{2\sqrt{2}}$ |
| $= \frac{1}{4}\sqrt{2}$              | $= -\frac{1}{4}\sqrt{2}$             |
| $\cot \theta = 2\sqrt{2}$            | $\cot \theta = -2\sqrt{2}$           |
| $\sec \theta = -\frac{3}{2\sqrt{2}}$ | $\sec \theta = \frac{3}{2\sqrt{2}}$  |
| $= -\frac{3}{4}\sqrt{2}$             | $= \frac{3}{4}\sqrt{2}$              |
| $\csc \theta = -3$                   | $\csc \theta = -3$                   |

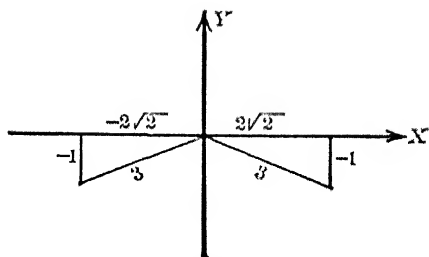


FIG. 19

## EXERCISES

1. Locate the following points and find all the functions of the angles formed by joining the points to the origin. Find the values of the angles.

- (a)  $(1, 1)$  (c)  $(-3, 3\sqrt{3})$  (e)  $(-2, -4)$  (g)  $(3, 4)$   
 (b)  $(1, -\sqrt{3})$  (d)  $(-2\sqrt{3}, -2)$  (f)  $(-3, 1)$  (h)  $(3, -2)$

2. Construct  $\theta$  and find all the functions of  $\theta$  in each of the possible quadrants if:

- (a)  $\tan \theta = -1$  (d)  $\cos \theta = -\frac{1}{2}$  (g)  $\tan \theta = 3$  (j)  $\sec \theta = \frac{1}{2}$   
 (b)  $\sec \theta = 3$  (e)  $\csc \theta = \frac{3}{2}$  (h)  $\cos \theta = \frac{3}{2}$  (k)  $\tan \theta = -\frac{1}{2}$   
 (c)  $\sin \theta = \frac{1}{3}$  (f)  $\cot \theta = -\frac{1}{2}$  (i)  $\sin \theta = -\frac{5}{13}$  (l)  $\cot \theta = \frac{5}{12}$

3. Determine the quadrant of each of the following angles:

- (a)  $\sin \theta = +$  (c)  $\tan \theta = -$  (e)  $\sec \theta = -$  (g)  $\sec \theta = +$   
        $\cos \theta = -$         $\sec \theta = -$         $\sin \theta = +$         $\csc \theta = +$   
 (b)  $\cos \theta = +$  (d)  $\sin \theta = -$  (f)  $\csc \theta = -$  (h)  $\cot \theta = -$   
        $\sin \theta = -$         $\tan \theta = +$         $\tan \theta = +$         $\sin \theta = -$

4. Construct  $\theta$  and determine all its functions if:

- (a)  $\sin \theta = \frac{3}{4}$  (b)  $\tan \theta = \frac{3}{4}$  (c)  $\csc \theta = -\frac{5}{3}$  (d)  $\cos \theta = -\frac{1}{2}$   
        $\cos \theta = +$         $\sec \theta = -$         $\sec \theta = -$         $\tan \theta = +$

5. Verify the eight fundamental identities of Section 4 when  $\theta$  is any angle.

26. **Reduction Formulas.** The next problem is to express functions of any angle in terms of functions of acute angles.

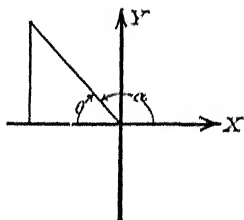


FIG. 20(a)

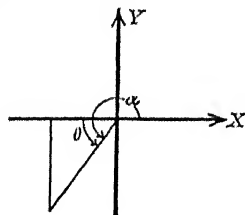


FIG. 20(b)

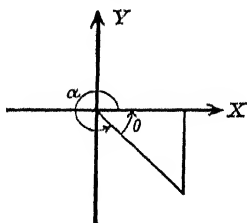


FIG. 20(c)

From Fig. 20(a), since  $\alpha = 180^\circ - \theta$ ,

any function  $\alpha = \text{function } (180^\circ - \theta) = \pm \text{same function } \theta$ .

From Fig. 20(b), since  $\alpha = 180^\circ + \theta$ ,

any function  $\alpha = \text{function } (180^\circ + \theta) = \pm \text{same function } \theta$ .

From Fig. 20(c), since  $\alpha = 360^\circ - \theta$ ,

any function  $\alpha = \text{function } (360^\circ - \theta) = \pm \text{same function } \theta$ .

\* The Greek letter "alpha."

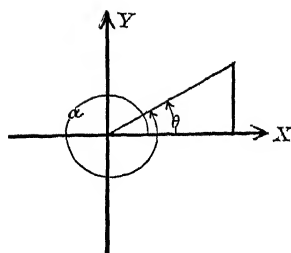


FIG. 20(d)

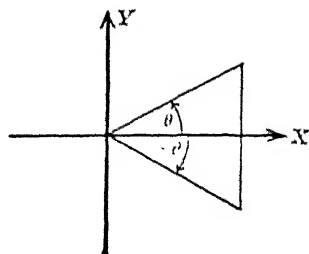


FIG. 20(e)

From Fig. 20(d), since  $\alpha = 360^\circ + \theta$ ,

any function  $\alpha = \text{function } (360^\circ + \theta) = \pm \text{same function } \theta$ .

From Fig. 20(e),

any function  $(-\theta) = \pm \text{same function } \theta$ .

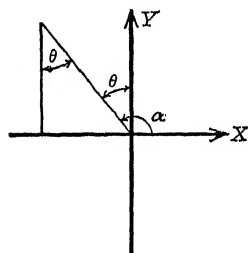


FIG. 21(a)

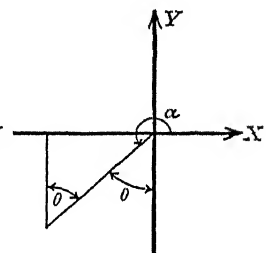


FIG. 21(b)

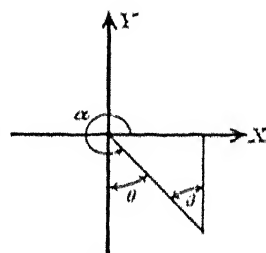


FIG. 21(c)

Again, from Fig. 21(a), since  $\alpha = 90^\circ + \theta$ ,  
any function  $(90^\circ + \theta) = \pm \text{function } (90^\circ - \theta) = \pm \text{co-function } \theta$ .

From Fig. 21(b), since  $\alpha = 270^\circ - \theta$ ,  
any function  $(270^\circ - \theta) = \pm \text{function } (90^\circ - \theta) = \pm \text{co-function } \theta$ .

From Fig. 21(c), since  $\alpha = 270^\circ + \theta$ ,  
any function  $(270^\circ + \theta) = \pm \text{function } (90^\circ - \theta) = \pm \text{co-function } \theta$ .

The above results may be collected into these formulas:

$$\text{Any function of } \begin{cases} 180^\circ \pm \theta \\ 360^\circ \pm \theta \end{cases} = \pm \text{same function of } \theta. \quad (16)$$

$$\text{Any function of } \begin{cases} 90^\circ + \theta \\ 270^\circ \pm \theta \end{cases} = \pm \text{co-function of } \theta. \quad (17)$$

The sign in each case is determined by the function and the quadrant indicated by the left-hand member.

For instance,

$$\cos 150^\circ = \cos (180^\circ - 30^\circ) = -\cos 30^\circ$$

since  $150^\circ$  is a second-quadrant angle, and the cosine is negative in the second quadrant.

**27. Functions of Special Angles.** Making use of the above formulas and the table on page 15, we have:

$$\sin 120^\circ = \sin (90^\circ + 30^\circ) = \cos 30^\circ = \frac{1}{2}\sqrt{3}$$

$$\cos 135^\circ = \cos (180^\circ - 45^\circ) = -\cos 45^\circ = -\frac{1}{2}\sqrt{2}$$

$$\sin 180^\circ = \sin (90^\circ + 90^\circ) = \cos 90^\circ = 0, \text{ etc.}$$

The following table of values of special angles includes the table given on page 15. The student should verify the new items by the above method and by constructing the angles and reading the values.

|     | $0^\circ$ | $30^\circ$            | $45^\circ$            | $60^\circ$            | $90^\circ$ | $120^\circ$            | $135^\circ$            | $150^\circ$            | $180^\circ$ |
|-----|-----------|-----------------------|-----------------------|-----------------------|------------|------------------------|------------------------|------------------------|-------------|
| sin | 0         | $\frac{1}{2}$         | $\frac{1}{2}\sqrt{2}$ | $\frac{1}{2}\sqrt{3}$ | 1          | $\frac{1}{2}\sqrt{3}$  | $\frac{1}{2}\sqrt{2}$  | $\frac{1}{2}$          | 0           |
| cos | 1         | $\frac{1}{2}\sqrt{3}$ | $\frac{1}{2}\sqrt{2}$ | $\frac{1}{2}$         | 0          | $-\frac{1}{2}$         | $-\frac{1}{2}\sqrt{2}$ | $-\frac{1}{2}\sqrt{3}$ | -1          |
| tan | 0         | $\frac{1}{3}\sqrt{3}$ | 1                     | $\sqrt{3}$            | $\infty$   | $-\sqrt{3}$            | -1                     | $-\frac{1}{3}\sqrt{3}$ | 0           |
| cot | $\infty$  | $\sqrt{3}$            | 1                     | $\frac{1}{3}\sqrt{3}$ | 0          | $-\frac{1}{3}\sqrt{3}$ | -1                     | $-\sqrt{3}$            | $\infty$    |
| sec | 1         | $\frac{2}{3}\sqrt{3}$ | $\sqrt{2}$            | 2                     | $\infty$   | -2                     | $-\sqrt{2}$            | $-\frac{2}{3}\sqrt{3}$ | -1          |
| csc | $\infty$  | 2                     | $\sqrt{2}$            | $\frac{2}{3}\sqrt{3}$ | 1          | $\frac{2}{3}\sqrt{3}$  | $\sqrt{2}$             | 2                      | $\infty$    |

|     | $210^\circ$            | $225^\circ$            | $240^\circ$            | $270^\circ$ | $300^\circ$            | $315^\circ$            | $330^\circ$            | $360^\circ$ |
|-----|------------------------|------------------------|------------------------|-------------|------------------------|------------------------|------------------------|-------------|
| sin | $-\frac{1}{2}$         | $-\frac{1}{2}\sqrt{2}$ | $-\frac{1}{2}\sqrt{3}$ | -1          | $-\frac{1}{2}\sqrt{3}$ | $-\frac{1}{2}\sqrt{2}$ | $-\frac{1}{2}$         | 0           |
| cos | $-\frac{1}{2}\sqrt{3}$ | $-\frac{1}{2}\sqrt{2}$ | $-\frac{1}{2}$         | 0           | $\frac{1}{2}$          | $\frac{1}{2}\sqrt{2}$  | $\frac{1}{2}\sqrt{3}$  | 1           |
| tan | $\frac{1}{3}\sqrt{3}$  | 1                      | $\sqrt{3}$             | $\infty$    | $-\sqrt{3}$            | -1                     | $-\frac{1}{3}\sqrt{3}$ | 0           |
| cot | $\sqrt{3}$             | 1                      | $\frac{1}{3}\sqrt{3}$  | 0           | $-\frac{1}{3}\sqrt{3}$ | -1                     | $-\sqrt{3}$            | $\infty$    |
| sec | $-\frac{2}{3}\sqrt{3}$ | $-\sqrt{2}$            | -2                     | $\infty$    | 2                      | $\sqrt{2}$             | $\frac{2}{3}\sqrt{3}$  | 1           |
| csc | -2                     | $-\sqrt{2}$            | $-\frac{2}{3}\sqrt{3}$ | -1          | $-\frac{2}{3}\sqrt{3}$ | $-\sqrt{2}$            | -2                     | $\infty$    |

## EXERCISES

Simplify:

1.  $a \tan 0^\circ + b \sin 180^\circ - c \cot 270^\circ$ .
2.  $a \tan 45^\circ + b \sin 270^\circ + (a-b) \cos 180^\circ$ .
3.  $(a^2 + b^2) \tan 225^\circ - 2ab \cos 180^\circ$ .
4.  $\sin 30^\circ \cos 180^\circ \tan 135^\circ \sec 60^\circ$ .
5.  $(8 \cot 90^\circ + 5 \tan 0^\circ + 4 \sin 150^\circ) \cos 90^\circ$ .
6.  $\sin (-45^\circ) \tan (-60^\circ) \cos (-30^\circ)$ .
7.  $\sec (-120^\circ) \csc (-150^\circ) \cot (-135^\circ)$ .
8.  $\cos (180^\circ - x) \tan (180^\circ + x)$ .
9.  $\sin (180^\circ + x) - \sin (90^\circ + x) \cos (180^\circ + x)$ .
10.  $\tan (180^\circ + x) \cot (270^\circ - x) - \tan 135^\circ$ .

Verify the following identities:

11.  $\sin 90^\circ = \sin 30^\circ \cos 60^\circ + \cos 30^\circ \sin 60^\circ$ .
12.  $\cos 30^\circ = \sin 90^\circ \sin 60^\circ + \cos 90^\circ \sin 60^\circ$ .
13.  $\sin 150^\circ = \sin 210^\circ \cos 60^\circ - \cos 210^\circ \sin 60^\circ$ .
14.  $\tan 150^\circ = \frac{\tan 120^\circ + \tan 30^\circ}{1 - \tan 120^\circ \tan 30^\circ}$ .
15. Find  $x$  if  $\tan x = \frac{6.301 \cos 134^\circ 10' \sin 213^\circ 18'}{8.431 \tan 310^\circ 18' \cot 75^\circ}$ .

SOLUTION.  $6.301 \dots \log = 0.79941$   
 $134^\circ 10' \dots \log \cos = 9.84308 - 10_n$   
 $213^\circ 18' \dots \log \sin = 9.73959 - 10_n$   
 $8.431 \dots \log \tan = 9.07412 - 10$   
 $310^\circ 18' \dots \log \cot = 9.92843 - 10_n$   
 $75^\circ \dots \log \tan = 0.57195$   
 $x = \underline{137^\circ 51' 34''} \dots \log \tan = 9.95658 - 10_n \quad \text{or } x = 317^\circ 51' 34''$

16. Find  $x$  if  $\sin x = \frac{\tan 210^\circ 35' \cos 200^\circ}{\cot 169^\circ \sin 172^\circ 35'}$ .
17. Find  $x$  if  $\tan x = \frac{24.542 \sin 243^\circ 34' 15'' \tan 98^\circ 45' 45''}{36.895 \cos 123^\circ 54' 30'' \cot 103^\circ 32' 36''}$ .

# CHAPTER VI

## GRAPHS OF THE FUNCTIONS

28. Line Values of the Functions. Each of the six trigonometric functions of an angle is *the ratio of two distances*, and not a length. However, it is possible, and at times convenient, to represent the functions by the lengths of line segments. This is done by making the denominator of each defining ratio equal to unity. Then the numerator represents the function.

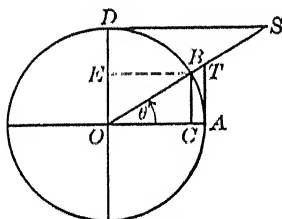


FIG. 22(a)

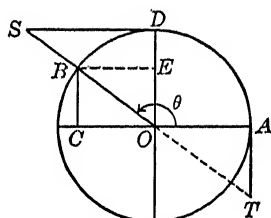


FIG. 22(b)

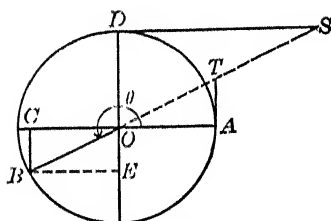


FIG. 22(c)

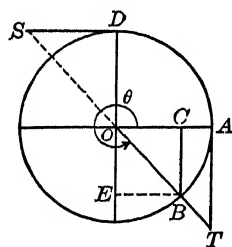


FIG. 22(d)

Let the angle  $\theta = \angle AOB$  (Fig. 22) be a central angle in a unit circle (radius=1). Then, no matter to which quadrant  $\theta$  belongs,

$$\begin{array}{lll} \sin \theta = CB & \tan \theta = AT & \sec \theta = OT \\ \cos \theta = OC & \cot \theta = DS & \csc \theta = OS \end{array}$$

Notice that  $OT$  and  $OS$  are considered positive when measured along a side of the angle, and negative when measured along a side produced through  $O$ . The usual convention determines whether the other sides are positive or negative.



Some other functions rarely used are sometimes employed in trigonometry, including the *versedsine* (written vers) and *coveredsine* (written covers). These are defined thus:

$$\text{vers } \theta = 1 - \cos \theta \quad (18)$$

$$\text{covers } \theta = 1 - \sin \theta \quad (19)$$

The line values of these functions are evidently  $\text{vers } \theta = CA$  and  $\text{covers } \theta = ED$ .

The eight fundamental identities (Section 4) may be derived directly from Fig. 22 for any angle of any magnitude.

**29. The Sine Curve.** In order to investigate the behavior of the sine of an angle as the angle varies, we may plot the curve  $y = \sin x$ . This can be done by assigning values to  $x$  and determining the corresponding values of  $y$ . The points  $(x, y)$  are then plotted as for algebraic curves, and a smooth curve is drawn through the points. A much neater method is as follows:

Draw a unit circle (Fig. 23) and let  $x$  be a central angle in it, measured as usual. Since in radian measure (Section 2)  $x = \frac{s}{r}$  and since  $r = 1$ , we have the subtended arc equal to the angle (in radians). Locate the coordinate axes, as shown in the figure.

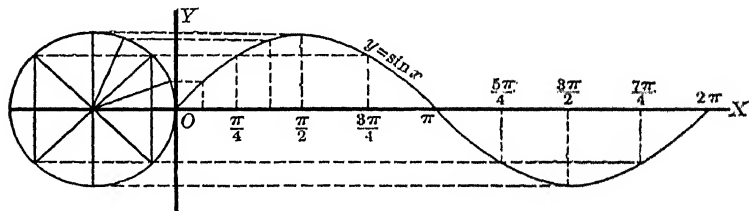


FIG. 23. GRAPH OF  $y = \sin x$

At convenient intervals along the circumference of the circle, draw the ordinates. These ordinates represent the sines of the angles  $x$  measured by the arcs from  $O$  to the points in question (Section 28). Now lay off on  $OX$  distances equal in lengths to the arcs on the circle. This can be done by dividing the distance  $2\pi = 6.28$  into parts. Points on the desired curve are then constructed as shown in Fig. 23.

Notice that as  $x$  increases from 0 to  $\frac{\pi}{2}$ ,  $\sin x$  increases from 0 to 1; as  $x$  increases from  $\frac{\pi}{2}$  to  $\pi$ ,  $\sin x$  decreases from 1 to 0; as  $x$  increases from  $\pi$  to  $\frac{3\pi}{2}$ ,  $\sin x$  decreases from 0 to  $-1$ ; and as  $x$  increases from  $\frac{3\pi}{2}$  to  $2\pi$ ,  $\sin x$  increases from  $-1$  to 0. The curve repeats itself for every multiple of  $2\pi$  described by  $x$ . For this reason the function  $y = \sin x$  is called a *periodic function of period  $2\pi$* .

**30. The Cosine Curve.** Since  $\sin(90^\circ + x) = \cos x$ , we can plot  $y = \cos x$  by merely plotting  $y = \sin(90^\circ + x)$ . That is, we measure off  $90^\circ = \frac{\pi}{2}$  on the circle before starting. Then proceed as for the sine curve (Fig. 24).

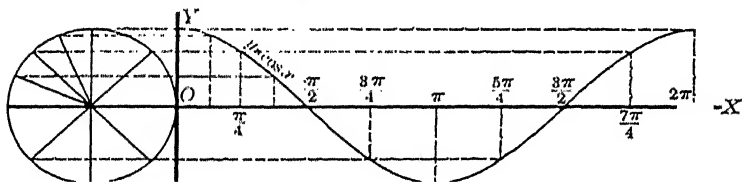
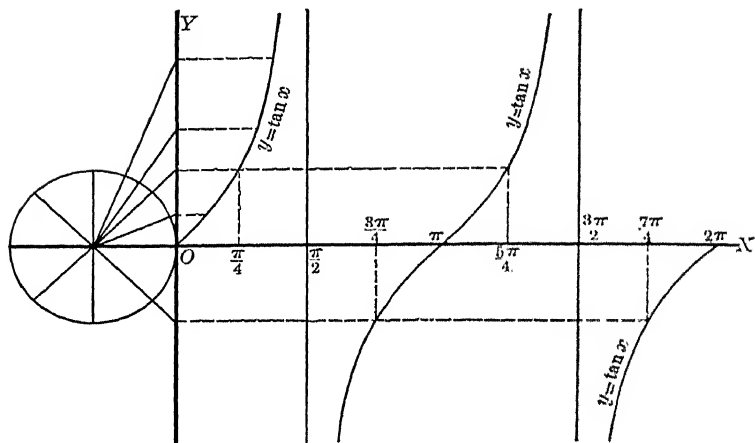
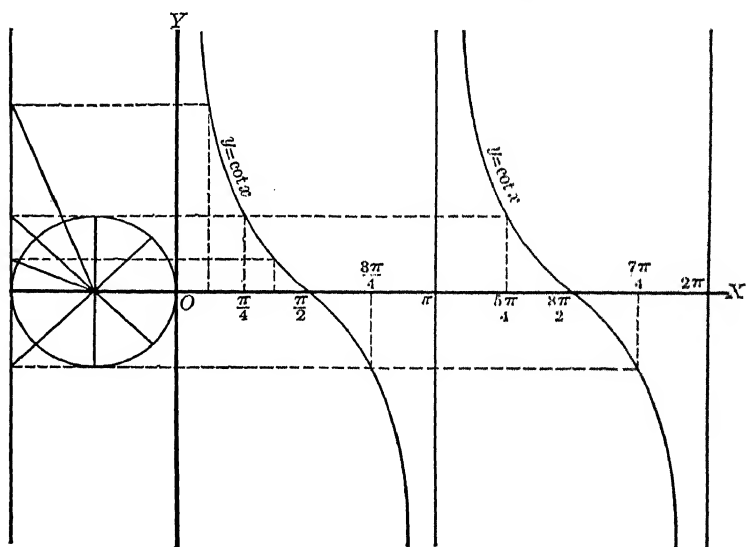


FIG. 24. GRAPH OF  $y = \cos x$

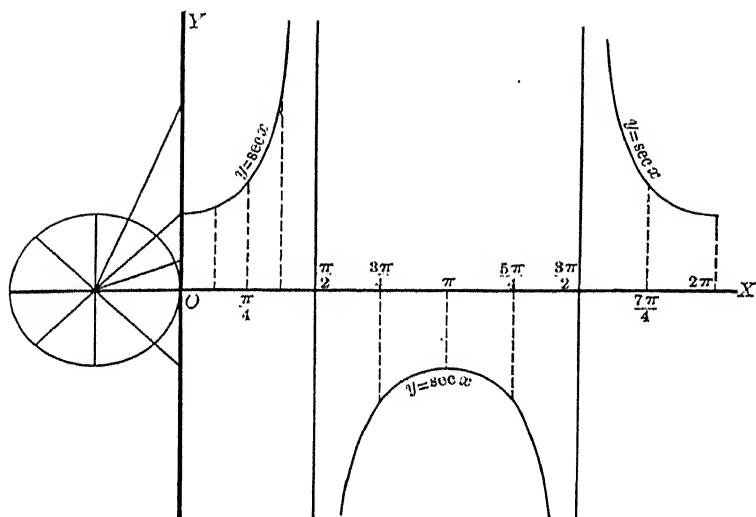
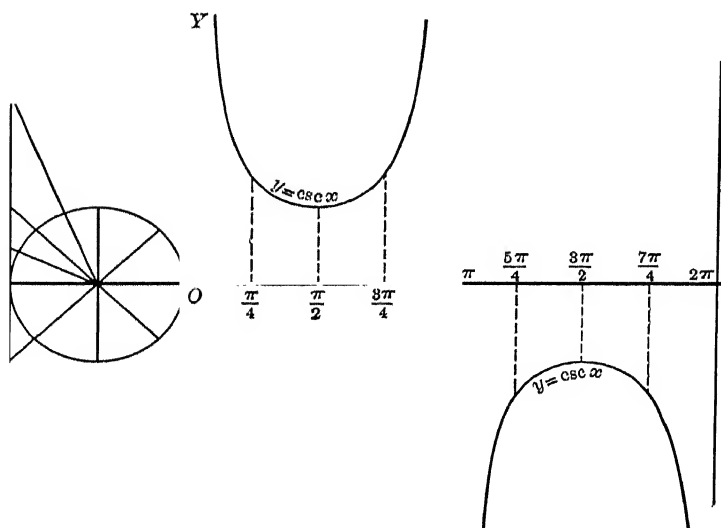
**31. The Tangent Curve.** Since the tangent of an angle can be represented by a distance measured along a vertical tangent to a unit circle, points of the tangent curve can be constructed and the curve can be drawn as in Fig. 25, page 46.

**32. The Cotangent Curve.** Since the usual line representation of the cotangent is by means of a horizontal line, in order to construct points on the curve  $y = \cot x$  we rotate the circle through  $90^\circ$  and plot as for the tangent curve. This construction is given in Fig. 26, page 46.

**33. The Secant and Cosecant Curves.** Since the secant and the cosecant are represented by lines radiating from the center of the unit circle, the method employed in constructing points on the four previous curves cannot be used for the curves  $y = \sec x$  or  $y = \csc x$ . Draw the lines representing the values

FIG. 25. GRAPH OF  $y = \tan x$ FIG. 26. GRAPH OF  $y = \cot x$ 

of the secant or cosecant as shown in Fig. 27 and 28, page 47, and transfer them by means of a pair of dividers to their proper positions on the graph.


 FIG. 27. GRAPH OF  $y = \sec x$ 

 FIG. 28. GRAPH OF  $y = \csc x$

## EXERCISES

1. Discuss the behavior of  $\cos x$  as  $x$  varies from 0 through  $\frac{\pi}{2}$ ,  $3\pi$  to  $2\pi$ .
2. Discuss the behavior of  $\tan x$  and  $\cot x$  as  $x$  varies in passing through the four quadrants.
3. Discuss the behavior of  $\sec x$  and  $\csc x$  as  $x$  varies in passing through the four quadrants.
4. Show that all six functions are periodic.

NOTE.  $\sin x$  and  $\cos x$  never have values greater than 1 or less than -1.  $\sec x$  and  $\csc x$  never have values between 1 and -1.  $\tan x$  and  $\cot x$  may have values whatsoever.

**34. Addition of Ordinates.** When drawing a curve  $y=f(x)+F(x)$ , where  $y=f(x)$  and  $y=F(x)$  are familiar curves, it is frequently convenient to employ a method known as *addition of ordinates*. The method employed is best given by an example.

*Illustration.* Plot the curve  $y=\sin x+\frac{1}{4}x$ .

First plot  $y=\sin x$  and then plot  $y=\frac{1}{4}x$ . These are the dashed curves in Fig. 29 below. At frequent intervals (often enough to make a smooth curve) add the ordinates of the two component curves by means of a pair of dividers. The resulting points lie on the desired curve.

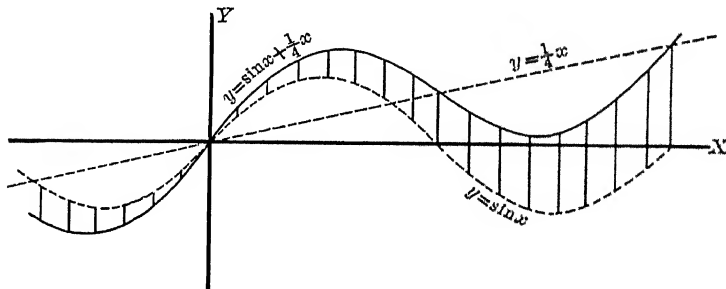


FIG. 29

## EXERCISES

Plot the curves:

1.  $y = \cos x + x$
2.  $y = \sin x + \cos x$
3.  $y = 1 - \cos x = \text{vers } x$
4.  $y = 2 \sin x$
5.  $y = x^2 - \sin x$
6.  $y = 1 - \sin x = \text{covers } x$
7.  $y = \tan x + \sin x$
8.  $y = \frac{1}{2} \sin x + 2 \cos x$

# CHAPTER VII

## TRIGONOMETRIC FUNCTIONS OF TWO ANGLES

35. **Functions of the Sum of Two Angles.** Let  $x$  and  $y$  be any two acute angles whose sum is acute. Place the angles adjacent to each other, as shown in Fig. 30. From any point  $C$  on the side of  $y$  which is not a side of  $x$ , draw lines  $CA$  and  $CD$  perpendicular to the sides of  $x$ . Draw  $DE$  perpendicular to  $CA$  and  $DB$  perpendicular to  $OA$ . Angle  $ECD = x$ , since their sides are perpendicular each to each.

From the figure,

$$\sin x = \frac{ED}{CD} \quad .ED = CD \sin x.$$

$$\cos x = \frac{EC}{CD} \quad .EC = CD \cos x.$$

$$\sin x = \frac{BD}{OD} \quad .BD = OD \sin x.$$

$$\cos x = \frac{OB}{OD} \quad .OB = OD \cos x.$$

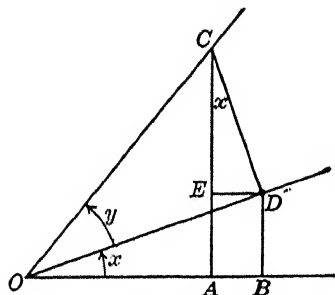


FIG. 30

$$\begin{aligned} \sin (x+y) &= \frac{AC}{OC} = \frac{AE+EC}{OC} = \frac{BD}{OC} + \frac{EC}{OC} = \frac{OD}{OC} \sin x + \frac{CD}{OC} \cos x \\ &= \cos y \sin x + \sin y \cos x. \end{aligned}$$

$$\begin{aligned} \cos (x+y) &= \frac{OA}{OC} = \frac{OB-AB}{OC} = \frac{OB}{OC} - \frac{ED}{OC} = \frac{OD}{OC} \cos x - \frac{CD}{OC} \sin x \\ &= \cos y \cos x - \sin y \sin x. \end{aligned}$$

Hence we have the important formulas:

$$\sin (x+y) = \sin x \cos y + \cos x \sin y \quad (20)$$

$$\cos (x+y) = \cos x \cos y - \sin x \sin y \quad (21)$$

Divide (20) by (21) and divide both numerator and denominator of the quotient by  $\cos x \cos y$ :

$$\begin{aligned} \tan (x+y) &= \frac{\sin (x+y)}{\cos (x+y)} = \frac{\sin x \cos y + \cos x \sin y}{\cos x \cos y - \sin x \sin y} \\ &= \frac{\frac{\sin x \cos y}{\cos x \cos y} + \frac{\cos x \sin y}{\cos x \cos y}}{\frac{\cos x \cos y}{\cos x \cos y} - \frac{\sin x \sin y}{\cos x \cos y}} = \frac{\tan x + \tan y}{1 - \tan x \tan y} \end{aligned}$$

Divide (21) by (20) and divide both numerator and denominator of the quotient by  $\sin x \sin y$  to establish Formula 23:

$$\tan(x+y) = \frac{\tan x + \tan y}{1 - \tan x \tan y} \quad (22)$$

$$\cot(x+y) = \frac{\cot x \cot y - 1}{\cot x + \cot y} \quad (23)$$

The above formulas have been established only when  $x$ ,  $y$ , and  $x+y$  are acute. Suppose now that  $x$  and  $y$  are acute, but that their sum is obtuse. Then, if  $A$  and  $B$  are the complements of  $x$  and  $y$ ,

$$\begin{array}{lll} x = 90^\circ - A & A = 90^\circ - x & x + y > 90^\circ \\ y = 90^\circ - B & B = 90^\circ - y & A + B < 90^\circ \\ \hline (x+y) = 180^\circ - (A+B) & (A+B) = 180^\circ - (x+y) & \end{array}$$

Then

$$\begin{aligned} \sin(x+y) &= \sin[180^\circ - (A+B)] = \sin(A+B) \\ &= \sin A \cos B + \cos A \sin B \\ &= \sin(90^\circ - x) \cos(90^\circ - y) + \cos(90^\circ - x) \sin(90^\circ - y) \\ &= \cos x \sin y + \sin x \cos y \\ &= \sin x \cos y + \cos x \sin y. \end{aligned}$$

Also,

$$\begin{aligned} \cos(x+y) &= \cos[180^\circ - (A+B)] = -\cos(A+B) \\ &= -\cos A \cos B + \sin A \sin B \\ &= -\cos(90^\circ - x) \cos(90^\circ - y) + \sin(90^\circ - x) \sin(90^\circ - y) \\ &= -\sin x \sin y + \cos x \cos y \\ &= \cos x \cos y - \sin x \sin y. \end{aligned}$$

In similar fashion Formulas 20 and 21, and hence 22 and 23, may be established for angles of any magnitude.

#### EXERCISES

1. Verify Formulas 20 and 21 when:

- $x$  is in the second quadrant and  $y$  is in the first quadrant.
- Both  $x$  and  $y$  are in the second quadrant.
- $x$  is in the third quadrant and  $y$  is in the second quadrant.
- $x$  is in the third quadrant and  $y$  is in the fourth quadrant.
- $x$  is in the first quadrant and  $y$  is in the third quadrant.

2. Find  $\cos 75^\circ$ .

$$\begin{aligned} \text{SOLUTION.} \quad \cos 75^\circ &= \cos(45^\circ + 30^\circ) = \cos 45^\circ \cos 30^\circ - \sin 45^\circ \sin 30^\circ \\ &= \frac{1}{2}\sqrt{2} \cdot \frac{1}{2}\sqrt{3} - \frac{1}{2}\sqrt{2} \cdot \frac{1}{2} = \frac{1}{4}(\sqrt{6} - \sqrt{2}). \end{aligned}$$

3. Reduce  $\sin(180^\circ+x)$ .

SOLUTION.  $\sin(180^\circ+x) = \sin 180^\circ \cos x + \cos 180^\circ \sin x$   
 $= 0 \cdot \cos x - 1 \cdot \sin x = -\sin x$ .

4. Given  $\sin A = \frac{3}{5}$  and  $\sin B = \frac{\sqrt{5}}{6}$ . Find  $\tan(A+B)$ .

SOLUTION. Draw the figures (Fig. 31) and substitute the values of  $\tan A$  and  $\tan B$ , read from the figures, in (22).

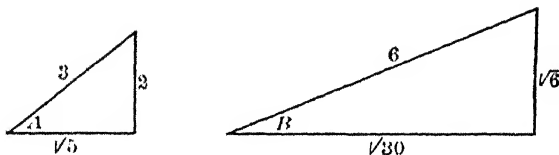


FIG. 31

$$\tan(A+B) = \frac{\tan A + \tan B}{1 - \tan A \tan B} = \frac{\frac{3}{\sqrt{5}} + \frac{\sqrt{5}}{6}}{1 - \frac{3}{\sqrt{5}} \cdot \frac{\sqrt{5}}{6}} = \sqrt{5}$$

5. Find: (a) sine and tangent of  $75^\circ$  (b) sine, cosine, and tangent of  $105^\circ$ .

6. Reduce:

(a)  $\sin(45^\circ+x)$  (c)  $\sin(150^\circ+x)$  (e)  $\tan(45^\circ+x)$

(b)  $\cos\left(\frac{\pi}{2}+y\right)$  (d)  $\tan\left(\frac{4\pi}{3}+x\right)$  (f)  $\cos(A+A)$

7. Given  $\sin x = \frac{3}{5}$ ,  $x < 90^\circ$ . Find (a)  $\sin(90^\circ+x)$  and (b)  $\cos(60^\circ+x)$ .

8. Given  $\sin A = \frac{1}{2}$ ,  $\tan B = \frac{1}{2}$ . Find (a)  $\sin(A+B)$  and (b)  $\cot(A+B)$ .

Verify the following identities:

9.  $\sin(60^\circ+x) - \cos(30^\circ-x) = \sin x$

10.  $1 + \tan(45^\circ+x) = \frac{2}{1 - \tan x}$

11.  $\frac{\sin(A+B)}{\cos A \cos B} = \tan A + \tan B$

Derive formulas for:

12.  $\sin(x+y+z)$  13.  $\cos(x+y+z)$  14.  $\tan(x+y+z)$

**36. Functions of the Difference of Two Angles.** Let  $x$  and  $y$  be any two acute angles with  $x > y$ . Place the angles as shown in Fig. 32, page 52. From any point  $C$  on the side of  $y$  that is not a side of  $x$ , draw lines  $CA$  and  $CD$  perpendicular to the sides of  $x$ .



Draw  $DB$  perpendicular to  $OA$  and  $CE$  perpendicular to  $DB$ .

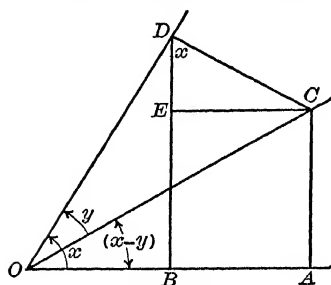


FIG. 32

Angle  $EDC = x$ , since their sides are perpendicular each to each.

From the figure,

$$\sin x = \frac{EC}{CD}. \quad \therefore EC = CD \sin x.$$

$$\cos x = \frac{ED}{CD}. \quad \therefore ED = CD \cos x.$$

$$\sin x = \frac{BD}{OD}. \quad \therefore BD = OD \sin x.$$

$$\cos x = \frac{OB}{OD}. \quad \therefore OB = OD \cos x.$$

$$\begin{aligned} \sin(x-y) &= \frac{AC}{OC} = \frac{BE}{OC} = \frac{BD-ED}{OC} = \frac{BD}{OC} - \frac{ED}{OC} = \frac{OD}{OC} \sin x - \frac{DC}{OC} \cos x \\ &= \cos y \sin x - \sin y \cos x \end{aligned}$$

$$\begin{aligned} \cos(x-y) &= \frac{OA}{OC} = \frac{OB+BA}{OC} = \frac{OB}{OC} + \frac{EC}{OC} = \frac{OD}{OC} \cos x + \frac{CD}{OC} \sin x \\ &= \cos y \cos x + \sin y \sin x. \end{aligned}$$

$$\text{Hence} \quad \sin(x-y) = \sin x \cos y - \cos x \sin y \quad (24)$$

$$\cos(x-y) = \cos x \cos y + \sin x \sin y \quad (25)$$

In a manner analogous to that used in obtaining (22) and (23), the student can derive

$$\tan(x-y) = \frac{\tan x - \tan y}{1 + \tan x \tan y} \quad (26)$$

$$\cot(x-y) = \frac{\cot x \cot y + 1}{\cot y - \cot x} \quad (27)$$

Formulas 24 and 25, and hence 26 and 27, can be proved for angles in any quadrant by the method employed in the last section.

#### EXERCISES

Reduce:

1.  $\sin(30^\circ - x)$

3.  $\tan(45^\circ - x)$

2.  $\cos(180^\circ - x)$

4.  $\cos\left(x - \frac{5\pi}{6}\right)$

5. Find all functions of  $15^\circ$ .

HINT.  $15^\circ = 45^\circ - 30^\circ$ .

6. Given  $\cos A = \frac{1}{3}$ ,  $\tan B = \frac{1}{4}$ . Find: (a)  $\sin(A-B)$  and (b)  $\tan(B-A)$ .

Verify the identities:

$$7. \cos(90^\circ - x) + \sin(180^\circ - x) = 2 \sin x$$

$$8. \tan(60^\circ + A) - \cot(30^\circ - A) = 0$$

**37. Functions of a Double Angle.** If in Formulas 20, 21, and 22 we let  $y=x$ , we get the following formulas:

$$\sin 2x = 2 \sin x \cos x \quad (28)$$

$$\cos 2x = \cos^2 x - \sin^2 x \quad (29)$$

$$= (1 - \sin^2 x) - \sin^2 x = 1 - 2 \sin^2 x$$

$$= \cos^2 x - (1 - \cos^2 x) = 2 \cos^2 x - 1$$

$$\tan 2x = \frac{2 \tan x}{1 - \tan^2 x} \quad (30)$$

If in Formulas 20, 21, and 22 we let  $y=2x$ , we get

$$\sin 3x = 3 \sin x - 4 \sin^3 x \quad (31)$$

$$\cos 3x = 4 \cos^3 x - 3 \cos x \quad (32)$$

$$\tan 3x = \frac{3 \tan x - \tan^3 x}{1 - 3 \tan^2 x} \quad (33)$$

**38. Half-angle Formulas.** Write the formula for  $\cos 2A$  thus:

$$\cos 2A = 1 - 2 \sin^2 A$$

Make the substitution  $2A=x$ . Then  $A = \frac{x}{2}$ , and we have

$$\cos x = 1 - 2 \sin^2 \frac{x}{2}$$

Solving, we get

$$\sin \frac{x}{2} = \pm \sqrt{\frac{1 - \cos x}{2}} \quad (34)$$

Similarly,  $\cos 2A = 2 \cos^2 A - 1$

Making the same substitution as above and solving, we find

$$\cos \frac{x}{2} = \pm \sqrt{\frac{1 + \cos x}{2}} \quad (35)$$

From (7), we have

$$\tan \frac{x}{2} = \frac{\sin \frac{x}{2}}{\cos \frac{x}{2}} = \frac{\pm \sqrt{\frac{1 - \cos x}{2}}}{\pm \sqrt{\frac{1 + \cos x}{2}}} \quad (36)$$

Or, on rationalizing the numerator and the denominator respectively, we have

$$\tan \frac{x}{2} = \frac{1 - \cos x}{\sin x}$$

$$\tan \frac{x}{2} = \frac{\sin x}{1 + \cos x}$$

## EXERCISES

1. Given  $\sin x = \frac{3}{5}$ . Find  $\sin 2x$ ,  $\cos 2x$ , and  $\tan 2x$ .
2. Given  $\sin \frac{1}{2}x = \frac{1}{3}$ . Find  $\tan x$ .
3. Given  $\csc x = 2$ . Find  $\sin 2x$  and  $\cos 2x$ .
4. Find  $\sin 22^\circ 30'$ .
5. Find  $\tan 15^\circ$  and  $\sin 15^\circ$  from the functions of  $30^\circ$ .
6. Find  $\sin 90^\circ$  and  $\cos 90^\circ$  from the functions of  $30^\circ$  and  $60^\circ$ .
7. Find the functions of  $120^\circ$  from those of  $30^\circ$  and  $90^\circ$ .
8. If  $\sin x = \frac{3}{4}$ , find the functions of  $3x$ .

Verify the identities:

$$9. (\sin x \pm \cos x)^2 = 1 \pm \sin 2x$$

$$10. \cos^4 A - \sin^4 A = \cos 2A$$

$$11. 2 \sin x + \sin 2x = \frac{2 \sin^3 x}{1 - \cos x}$$

$$12. \tan \left( \frac{\pi}{4} + \frac{x}{2} \right) = \sec x + \tan x$$

$$13. \sin 4\theta = 8 \cos^3 \theta \sin \theta - 4 \cos \theta \sin \theta$$

$$14. \cos 4\theta = 8 \cos^4 \theta - 8 \cos^2 \theta + 1$$

**39. The Sum and Difference Formulas.** The so-called "Big Four," collected from previous sections, are:

$$\sin (x+y) = \sin x \cos y + \cos x \sin y \quad (20)$$

$$\cos (x+y) = \cos x \cos y - \sin x \sin y \quad (21)$$

$$\sin (x-y) = \sin x \cos y - \cos x \sin y \quad (24)$$

$$\cos (x-y) = \cos x \cos y + \sin x \sin y \quad (25)$$

Adding and subtracting these by pairs, as indicated, gives

$$\sin (x+y) + \sin (x-y) = 2 \sin x \cos y$$

$$\sin (x+y) - \sin (x-y) = 2 \cos x \sin y$$

$$\cos (x+y) + \cos (x-y) = 2 \cos x \cos y$$

$$\cos (x+y) - \cos (x-y) = -2 \sin x \sin y$$

Now make the substitutions  $x+y=A$  and  $x-y=B$  and solve for  $x$  and  $y$ :

$$x = \frac{1}{2}(A+B)$$

$$y = \frac{1}{2}(A-B)$$

Substituting in the above, we have:

$$\sin A + \sin B = 2 \sin \frac{1}{2}(A+B) \cos \frac{1}{2}(A-B) \quad (37)$$

$$\sin A - \sin B = 2 \cos \frac{1}{2}(A+B) \sin \frac{1}{2}(A-B) \quad (38)$$

$$\cos A + \cos B = 2 \cos \frac{1}{2}(A+B) \cos \frac{1}{2}(A-B) \quad (39)$$

$$\begin{aligned} \cos A - \cos B &= -2 \sin \frac{1}{2}(A+B) \sin \frac{1}{2}(A-B) \quad (40) \\ &= 2 \sin \frac{1}{2}(A+B) \sin \left[-\frac{1}{2}(A-B)\right] \\ &= 2 \sin \frac{1}{2}(B+A) \sin \frac{1}{2}(B-A). \end{aligned}$$

## EXERCISES

Verify the following identities:

1.  $\sin 5x - \sin 3x = 2 \sin x \cos 4x$
2.  $2 \cos (45^\circ + \frac{1}{2}x) \cos (45^\circ - \frac{1}{2}x) = \cos x$
3.  $\cos 2x - \cos 4x = 2 \sin x \sin 3x$
4.  $\cos (30^\circ - x) - \cos (30^\circ + x) = \sin x$
5.  $\sin 70^\circ - \sin 50^\circ = \sin 10^\circ$
6.  $\frac{\sin 3x + \sin x}{\cos 3x + \cos x} = \tan 2x$
7.  $\sin (x+y) + \cos (x-y) = (\sin x + \cos x) (\sin y + \cos y)$
8.  $\sin (x-y) + \cos (x+y) = (\sin x + \cos x) (\cos y - \sin y)$
9.  $\sin (x+y) - \cos (x-y) = (\sin x - \cos x) (\cos y - \sin y)$
10.  $\sin (x-y) - \cos (x+y) = (\sin x - \cos x) (\sin y + \cos y)$
11.  $\cos x \sin (x+30^\circ) - \sin x \cos (x+30^\circ) = \frac{1}{2}$
12.  $\cos x \cos (x-60^\circ) + \sin x \sin (x-60^\circ) = \frac{1}{2}$
13.  $\sin x \sin (x+30^\circ) + \sin x \cos (x+120^\circ) = 0$
14.  $\cos (x+30^\circ) \cos (x-30^\circ) + \sin (x+60^\circ) \sin (x-60^\circ) = 0$
15.  $\frac{\sin (45^\circ + x) + \sin (45^\circ - x)}{\sin (45^\circ + x) - \sin (45^\circ - x)} = \cot x$
16.  $\frac{\tan (45^\circ + x) - \tan (45^\circ - x)}{\tan (45^\circ + x) + \tan (45^\circ - x)} = \sin 2x$
17.  $\frac{\cos (45^\circ + x) + \cos (45^\circ - x)}{\cos (45^\circ + x) - \cos (45^\circ - x)} = -\cot x$
18.  $\frac{\sin x - \cos x}{\sin x + \cos x} = \tan (x - 45^\circ)$

Verify the following if  $A+B+C=180^\circ$ :

19.  $\sin A + \sin B + \sin C = 4 \cos \frac{1}{2}A \cos \frac{1}{2}B \cos \frac{1}{2}C$
20.  $\cos A + \cos B + \cos C = 4 \sin \frac{1}{2}A \sin \frac{1}{2}B \sin \frac{1}{2}C + 1$
21.  $\tan A + \tan B + \tan C = \tan A \tan B \tan C$
22.  $\sin A + \sin B - \sin C = 4 \sin \frac{1}{2}A \sin \frac{1}{2}B \cos \frac{1}{2}C$
23.  $\cos A + \cos B - \cos C = 4 \cos \frac{1}{2}A \cos \frac{1}{2}B \sin \frac{1}{2}C - 1$
24.  $\sin 2A + \sin 2B + \sin 2C = 4 \sin A \sin B \sin C$
25.  $\cos 2A + \cos 2B + \cos 2C = -4 \cos A \cos B \cos C - 1$
26.  $\tan \frac{1}{2}A \tan \frac{1}{2}B + \tan \frac{1}{2}B \tan \frac{1}{2}C + \tan \frac{1}{2}C \tan \frac{1}{2}A = 1$
27.  $\cot \frac{1}{2}A + \cot \frac{1}{2}B + \cot \frac{1}{2}C = \cot \frac{1}{2}A \cot \frac{1}{2}B \cot \frac{1}{2}C$

## CHAPTER VIII

### FORMULAS CONNECTED WITH A TRIANGLE

40. The Law of Sines. In any triangle,

$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c} \quad (41)$$

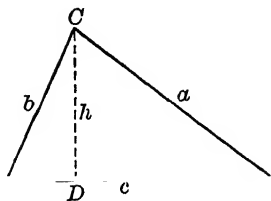


FIG. 33(a)

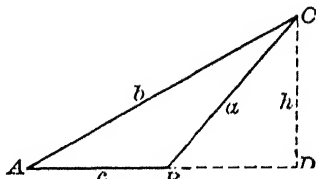


FIG. 33(b)

PROOF. Draw the altitude  $h$  from the vertex  $C$  (Fig. 33).

Then  $\sin A = \frac{h}{b}$  and  $\sin B = \frac{h}{a}$

Solve for  $h$ :  $h = b \sin A$  and  $h = a \sin B$

Equate the two values of  $h$ :  $b \sin A = a \sin B$

Divide both sides by  $ab$ :  $\frac{\sin A}{a} = \frac{\sin B}{b}$

If we draw the altitude from vertex  $A$  and use analogous reasoning, we obtain  $\frac{\sin B}{b} = \frac{\sin C}{c}$ . Hence the theorem:

*In any triangle, the sines of the angles are proportional to the opposite sides.*

41. The Law of Cosines. In any triangle,

$$a^2 = b^2 + c^2 - 2bc \cos A \quad (42)$$

PROOF. From Fig. 33(a):

$$a^2 = h^2 + (DB)^2$$

Substitute  $h^2 = b^2 - (AD)^2$ :  $a^2 = b^2 - (AD)^2 + (DB)^2 = b^2 + [(DB)^2 - (AD)^2]$

Factor last two terms:  $a^2 = b^2 + (DB + AD)(DB - AD)$

But  $DB + AD = c$  and  $DB = c - AD$ . Hence

$$a^2 = b^2 + c(c - 2AD)$$

But  $AD = b \cos A$ . Hence  $a^2 = b^2 + c(c - 2b \cos A) = b^2 + c^2 - 2bc \cos A$

The student should supply the variations necessary to prove the theorem for Fig. 33(b).

Stated in words, the law of cosines is:

*The square of any side of a triangle is equal to the sum of the squares of the other two sides minus twice the product of these two sides and the cosine of the included angle.*

Applying the theorem to each of the three sides in turn, we have:

$$\begin{aligned}a^2 &= b^2 + c^2 - 2bc \cos A & b^2 &= c^2 + a^2 - 2ca \cos B \\c^2 &= a^2 + b^2 - 2ab \cos C\end{aligned}$$

**42. The Law of Tangents.** In any triangle,

$$\frac{a+b}{a-b} = \frac{\tan \frac{1}{2}(A+B)}{\tan \frac{1}{2}(A-B)} \quad (43)$$

PROOF. If we apply composition and division to the law of sines,  $\frac{a}{b} = \frac{\sin A}{\sin B}$ , we get  $\frac{a+b}{a-b} = \frac{\sin A + \sin B}{\sin A - \sin B}$ . Making use of (37) and (38), we have

$$\begin{aligned}\frac{\sin A + \sin B}{\sin A - \sin B} &= \frac{2 \sin \frac{1}{2}(A+B) \cos \frac{1}{2}(A-B)}{2 \cos \frac{1}{2}(A+B) \sin \frac{1}{2}(A-B)} \\&= \tan \frac{1}{2}(A+B) \cot \frac{1}{2}(A-B).\end{aligned}$$

Hence

$$\frac{a+b}{a-b} = \frac{\tan \frac{1}{2}(A+B)}{\tan \frac{1}{2}(A-B)} \quad (43)$$

$$\frac{b+c}{b-c} = \frac{\tan \frac{1}{2}(B+C)}{\tan \frac{1}{2}(B-C)} \quad (44)$$

$$\frac{c+a}{c-a} = \frac{\tan \frac{1}{2}(C+A)}{\tan \frac{1}{2}(C-A)} \quad (45)$$

**43. The Half-angle Formulas.** In the law of cosines

$$a^2 = b^2 + c^2 - 2bc \cos A$$

substitute  $\cos A = 1 - 2 \sin^2 \frac{A}{2}$  from (34). Then

$$a^2 = b^2 + c^2 - 2bc + 4bc \sin^2 \frac{1}{2}A$$

Solve for  $\sin^2 \frac{1}{2}A$ :

$$\sin^2 \frac{1}{2}A = \frac{a^2 - (b^2 - 2bc + c^2)}{4bc} = \frac{a^2 - (b-c)^2}{4bc} = \frac{(a-b+c)(a+b-c)}{4bc}$$

For convenience, let

$$a+b+c=2s \quad (46)$$

Subtract  $2c$  and  $2b$  in turn from each side of (46):

$$a+b-c=2(s-c) \quad \text{and} \quad a-b+c=2(s-b).$$

Hence

$$\sin \frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{bc}} \quad (47)$$

Similarly,

$$\sin \frac{1}{2}B = \sqrt{\frac{(s-c)(s-a)}{ca}} \quad (48)$$

and

$$\sin \frac{1}{2}C = \sqrt{\frac{(s-a)(s-b)}{ab}} \quad (49)$$

A trigonometric function in fairly common use is called the *haversine* (abbreviated *hav*). It is defined thus:

$$\text{hav } A = \sin^2 \frac{1}{2}A$$

Hence Formulas 47, 48, and 49 become

$$\text{hav } A = \frac{(s-b)(s-c)}{bc} \quad (50)$$

$$\text{hav } B = \frac{(s-c)(s-a)}{ca} \quad (51)$$

$$\text{hav } C = \frac{(s-a)(s-b)}{ab} \quad (52)$$

If in the law of cosines (42) we substitute  $\cos A = 2 \cos^2 \frac{1}{2}A - 1$  from Formula 35, we get

$$a^2 = b^2 + c^2 - 2bc(2 \cos^2 \frac{1}{2}A - 1) = b^2 + c^2 - 4bc \cos^2 \frac{1}{2}A + 2bc$$

Solve for  $\cos^2 \frac{1}{2}A$ :

$$\begin{aligned} \cos^2 \frac{1}{2}A &= \frac{b^2 + 2bc + c^2 - a^2}{4bc} = \frac{(b+c)^2 - a^2}{4bc} \\ &= \frac{(b+c+a)(b+c-a)}{4bc} = \frac{s(s-a)}{bc} \end{aligned}$$

Hence

$$(53)$$

Similarly,

$$\cos \frac{1}{2}B = \sqrt{\frac{s(s-b)}{ca}} \quad (54)$$

and

$$(55)$$

Divide Formula 47 by Formula 53, etc.:

$$\tan \frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}} \quad (56)$$

$$= \sqrt{\frac{(s-c)(s-a)}{s(s-b)}} \quad (57)$$

$$\tan \frac{1}{2}C = \sqrt{\frac{(s-a)(s-b)}{s(s-c)}} \quad (58)$$

We may write Formula 56 in this form:

$$\tan \frac{1}{2}A = \sqrt{\frac{(s-a)(s-b)(s-c)}{s(s-a)^2}} = \frac{r}{(s-a)}$$

In this formula,

$$r^* = \sqrt{\frac{(s-a)(s-b)(s-c)}{s}} \quad (59)$$

Hence

$$\tan \frac{1}{2}A = \frac{r}{s-a} \quad (60)$$

and

$$\tan \frac{1}{2}B = \frac{r}{s-b} \quad (61)$$

and

$$\tan \frac{1}{2}C = \frac{r}{s-c} \quad (62)$$

\*See Section 51 for a geometric meaning of  $r$ .



## CHAPTER IX

### SOLUTION OF THE OBLIQUE TRIANGLE

**44. Introduction.** The following formulas, derived in the last chapter, will be used in solving oblique triangles. The general procedure is to select a formula that contains the given parts and one unknown part and to solve for the unknown part.

$$\sin A \quad \sin B \quad \sin C \quad (41)$$

$$A + B + C = 180^\circ \quad (63)$$

$$\frac{\tan \frac{1}{2}(A-B)}{\tan \frac{1}{2}(A+B)} = \frac{a-b}{a+b}, \text{ etc.} \quad (43)$$

$$\tan \frac{1}{2}A = \frac{s-a}{s-a}, \text{ etc.} \quad (60)$$

$$= \sqrt{\frac{(s-a)(s-b)(s-c)}{s}} \quad (59)$$

$$s = \frac{1}{2}(a+b+c) \quad (46)$$

For convenience in solving, triangles are divided into four cases, depending on the parts given.

**45. Case I. Given the Three Sides.** Formula 60, in connection with Formulas 59 and 46, will give the angles. As a check, use Formula 63. See the illustration on page 61.

#### EXERCISES

Solve the following triangles:

- |               |                |                |              |
|---------------|----------------|----------------|--------------|
| 1. $a=513.42$ | 2. $b=623.65$  | 3. $c=519.85$  | 4. $a=4$     |
| 5. $a=1.6387$ | 6. $b=4.3589$  | 7. $c=4.8063$  | 8. $a=20.4$  |
| 9. $a=42.786$ | 10. $b=67.428$ | 11. $c=79.857$ | 12. $a=2500$ |
|               |                |                | 13. $b=3600$ |
|               |                |                | 14. $c=4000$ |

**46. Case II. Given a Side and Two Angles.** Suppose the given parts are  $A$ ,  $B$ , and  $a$ . The third angle is obtained at once from Formula 63. The two unknown sides can then be found by means of Formula 41.

*Illustration of Case I.* Solve the triangle:  $a = 201.65$ ,  $b = 346.75$ ,  $c = 411.6$ .

*SOLUTION.* The work should be arranged *exactly* as follows:

$$s = \frac{1}{2}(a + b + c) \quad r = \sqrt{\frac{(s-a)(s-b)(s-c)}{s}}$$

$$\tan \frac{1}{2}A = \frac{r}{s-a} \quad \tan \frac{1}{2}B = \frac{r}{s-b} \quad \tan \frac{1}{2}C = \frac{r}{s-c}$$

CHECK.  $A + B + C = 180^\circ$

$$\underline{a} = 201.65$$

$$\underline{b} = 346.75$$

$$\underline{c} = 411.6$$

$$2s = 960.00$$

$$s = 480. \quad \dots \dots \dots \text{col} = 7.31876 - 10$$

$$s - a = 278.35 \quad \dots \dots \dots \text{log} = 2.44459 \quad \dots \dots \dots \text{col} = 7.55541 - 10$$

$$s - b = 133.25 \quad \dots \dots \dots \text{log} = 2.12467 \quad \dots \dots \dots \text{col} = 7.87533 - 10$$

$$s - c = 68.4 \quad \dots \dots \dots \text{log} = 1.83506 \quad \dots \dots \dots \text{col} = 8.16494 - 10$$

$$r^2 = \dots \dots \dots \text{log} = 3.72308$$

$$r = \dots \dots \dots \text{log} = 1.86154$$

$$A = 29^\circ 16' 32'' \quad \dots \dots \dots \frac{1}{2}A = 14^\circ 38' 16'' \quad \dots \dots \dots \text{log tan} = 1.86154$$

$$B = 57^\circ 14' 00'' \quad \dots \dots \dots \frac{1}{2}B = 28^\circ 37' 00'' \quad \dots \dots \dots \text{log tan} = 9.73687 - 10$$

$$C = 93^\circ 29' 28'' \quad \dots \dots \dots \frac{1}{2}C = 46^\circ 44' 44'' \quad \dots \dots \dots \text{log tan} = 0.02648$$

$$180^\circ 00' 00''$$

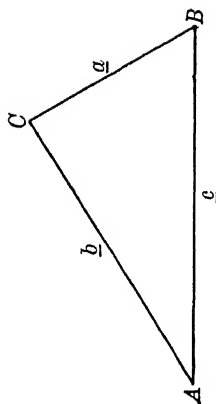


FIG. 34

*Illustration of Case II.* Given:  $a = 14.726$ ,  $A = 22^\circ 17' 06''$ ,  
 $B = 106^\circ 47' 58''$ .

SOLUTION. The work should be arranged *exactly* as follows:

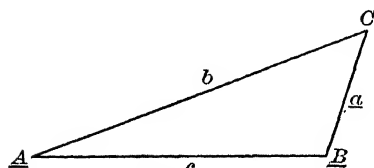


FIG. 35

$$C = 180^\circ - (A + B) \\ = 50^\circ 54' 56''$$

$$b = \frac{a \sin B}{\sin A}$$

$$c = \frac{a \sin C}{\sin A}$$

$$\text{CHECK. } \tan \frac{1}{2}C = \frac{r}{s-c}$$

$$\begin{aligned} &= 22^\circ 17' 06'' \dots \text{col sin} = 0.42112 \dots \text{col sin} = 0.42112 \\ &= 106^\circ 47' 58'' \dots \text{log sin} = 9.98106 - 10 \\ &= 50^\circ 54' 56'' \dots \text{log sin} = 9.88998 - 10 \\ &= 14.726 \dots \text{log} = 1.16808 \dots \text{log} = \underline{1.16808} \\ &= 37.176 \dots \text{log} = 1.57026 \\ &= \underline{30.143} \dots \text{log} = 1.47918 \\ &= 82.045 \quad (\text{The following work is the check.}) \\ &= 41.0225 \dots \text{col} = 8.38697 - 10 \\ s-a &= 26.2965 \dots \text{log} = 1.41990 \\ s-b &= 3.8465 \dots \text{log} = 0.58507 \\ s-c &= 10.8795 \dots \text{log} = 1.03661 \\ r^2 &\dots \text{log} = 1.42855 \\ r &\dots \text{log} = 0.71428 \\ s-c &\dots \text{col} = 8.96339 - 10 \\ \frac{1}{2}C &= 25^\circ 27' 27'' \dots \text{log tan} = 9.67767 - 10 \end{aligned}$$

## EXERCISES

Solve the triangles:

- |                            |                          |              |
|----------------------------|--------------------------|--------------|
| 1. $A = 45^\circ$          | $B = 60^\circ$           | $c = 100$    |
| 2. $A = 72^\circ 36'$      | $C = 28^\circ 48'$       | $b = 275$    |
| 3. $B = 39^\circ 38' 41''$ | $C = 98^\circ 23' 14''$  | $b = 236.48$ |
| 4. $B = 82^\circ 23' 13''$ | $C = 48^\circ 54' 17''$  | $c = 1008.5$ |
| 5. $A = 5^\circ 45' 30''$  | $B = 36^\circ 32' 45''$  | $a = 243.5$  |
| 6. $B = 58^\circ 06' 52''$ | $C = 103^\circ 48' 02''$ | $a = 102.45$ |
| 7. $A = 22^\circ 18' 14''$ | $B = 148^\circ 29' 16''$ | $b = 204.56$ |

8. In any triangle, let  $h$  denote the altitude on the side  $c$ . Prove that  $h = \frac{c \sin A \sin B}{\sin(A+B)}$ .

9. In any triangle, let  $p$  represent the segment of the perpendicular bisector of  $c$  included within the triangle. Prove that  $p = \frac{1}{2}c \tan A$  when  $A < B$ , or  $p = \frac{1}{2}c \tan B$  when  $A > B$ .

47. Case III. Given Two Sides and the Included Angle. Use Formulas 63, 43, and 41.

*Illustration.* Given  $a=2467.8$ ,  $b=4016.5$ ,  $C=32^\circ 47' 18''$ .

*SOLUTION.* The work should be arranged exactly as follows:

$$B+A=180^\circ-C=147^\circ 12' 42''$$

$$\tan \frac{1}{2}(B-A) = \frac{b-a}{b+a} \tan \frac{1}{2}(B+A)$$

$$c = \frac{a \sin C}{\sin A}$$

CHECK.  $c = \frac{b \sin C}{\sin B}$

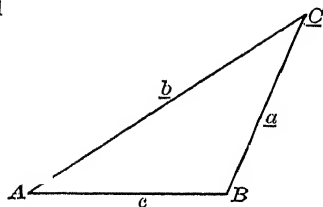


FIG. 36

$$\begin{aligned} b &= 4016.5 \dots \dots \dots \log = 3.60385 \\ a &= 2467.8 \dots \dots \dots \log = 3.39231 \\ b-a &= 1548.7 \dots \log = 3.18997 \\ b+a &= 6484.3 \dots \text{col} = 6.18814-10 \\ C &= 32^\circ 47' 18'' \dots \dots \log \sin = 9.73363-10, \log \sin = 9.73363-10 \\ \frac{1}{2}(B+A) &= 73^\circ 36' 21'' \log \tan = 0.53135 \\ \frac{1}{2}(B-A) &= 39^\circ 04' 14'' \log \tan = 0.90946-10 \\ B &= 112^\circ 40' 35'' \dots \dots \text{col} \sin = 0.03494 \\ A &= 34^\circ 32' 07'' \dots \dots \text{col} \sin = 0.24648 \\ c &= 2357.3 \dots \dots \log = 3.37242 \dots \dots \log = 3.37242 \end{aligned}$$

#### EXERCISES

Solve the triangles:

1.  $a=513.42$   $b=623.65$   $C=46^\circ 35' 50''$
2.  $a=40$   $c=50$   $B=60^\circ$
3.  $b=98.75$   $c=76.25$   $A=125^\circ 40'$
4.  $a=22.253$   $b=32.574$   $C=88^\circ 56' 25''$
5.  $a=1002.5$   $c=784.5$   $B=56^\circ 28' 45''$

48. Case IV. Given Two Sides and the Angle Opposite One of Them. Suppose we designate the given parts by  $a$ ,  $b$ , and  $A$ . There are several possibilities.

If  $A$  is acute, there are

- (1) Two solutions if  $h < a < b$ , where  $h$  is the altitude from  $C$ . (See Fig. 37, page 64.)
- (2) One solution if  $a = h$  (right triangle) or if  $a > b$ . (See Fig. 37 and 38, page 64.)
- (3) No solution if  $a < h$ . (See Fig. 39, page 64.)

\*Note that in using the law of tangents, the larger side and the larger angle are written first.

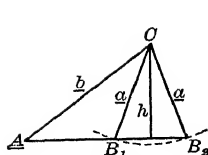


FIG. 37

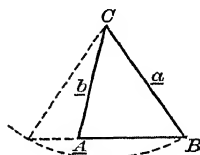


FIG. 38

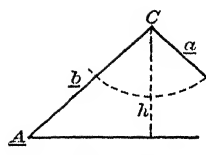


FIG. 39

If  $A$  is obtuse, there is

- (4) One solution if  $a > b$  (Fig. 40).  
 (5) No solution if  $a < b$  (Fig. 41).

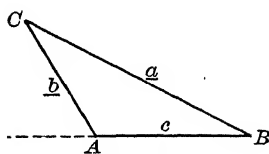


FIG. 40

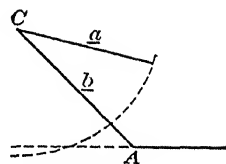


FIG. 41

The number of solutions in any particular case appears also from the computation, so that the above determination is unnecessary except as a check.

The only formulas necessary are the law of sines and (63).

*Illustration 1.* Given:

$$a = 106.75, \quad b = 176.25,$$

$$A = 36^\circ 17' 36''.$$

*SOLUTION.* The work should be arranged *exactly* as follows:

$$\sin B = b \sin A$$

$$C = 180^\circ - (A + B)$$

$$c = \frac{a \sin C}{\sin A}$$

$$\text{CHECK. } \tan \frac{1}{2}C = \frac{r}{s - c}$$

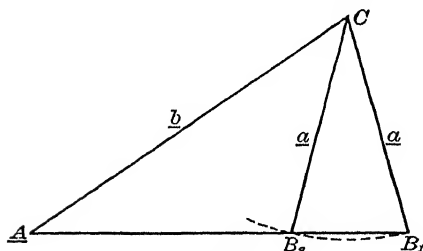


FIG. 42

$$\underline{a} = 106.75 \dots \text{col} = 7.97163 - 10 \dots \log = 2.02837 \dots \log = 2.02837$$

$$\underline{b} = 176.25 \dots \log = 2.24613$$

$$\underline{A} = 36^\circ 17' 36'' \dots \log \sin = 9.77226 - 10 \dots \text{col} \sin = 0.22774 \dots \text{col} \sin = 0.22774$$

$$\underline{B_1} = 77^\circ 46' 00'' \dots \log \sin = 9.99002 - 10$$

$$\underline{B_2} = 102^\circ 14' 00''$$

$$\underline{C_1} = 65^\circ 56' 24'' \dots \log \sin = 9.96052 - 10$$

$$\underline{C_2} = 41^\circ 28' 24'' \dots \log \sin = 9.82104 - 10$$

$$\underline{c_1} = 164.68 \dots \log = 2.21663$$

$$\underline{c_2} = 119.44 \dots \log = 2.07715$$

The work for the check may be arranged as in Case II. (See page 62.)

The two solutions first appear when we attempt to obtain  $B$  from the logarithm of its sine. In such a case there is an acute angle and its obtuse supplement, due to the fact that  $\sin (180^\circ - x) = \sin x$ . Such an ambiguity does not arise when an angle is obtained from the logarithm of its cosine or of its tangent, since  $\cos (180^\circ - x) = -\cos x$  and  $\tan (180^\circ - x) = -\tan x$ .

*Illustration 2.* Given:  $a=106.75$ ,  $b=76.25$ ,  $A=36^\circ 17' 36''$ .

SOLUTION

$$\sin B = \frac{b \sin A}{a}$$

$$C = 180^\circ - (A + B)$$

$$c = \frac{a \sin C}{\sin A}$$

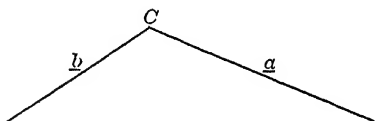


FIG. 43

CHECK.  $\tan \frac{1}{2}C = \frac{s-c}{s-a}$

$$\frac{a}{b} = 106.75 \dots \dots \text{col} = 7.97163 - 10. \dots \log = 2.02837$$

$$\frac{b}{a} = 76.25 \dots \dots \log = 1.88224$$

$$A = 36^\circ 17' 36'' \dots \log \sin = 9.77226 - 10. \dots \text{col} \sin = 0.22774$$

$$B = 25^\circ 00' 40'' \dots \log \sin = 9.62613 - 10$$

$$C = 118^\circ 41' 44'' \dots \dots \dots \log \sin = 9.94309 - 10$$

$$c = 158.2 \dots \dots \dots \log = 2.19920$$

The other apparent value of  $B$ ,  $154^\circ 59' 20''$ , is so large that when it is added to  $A$  it gives a sum greater than  $180^\circ$ . Hence there is only one solution. This is also apparent since  $a > b$  and  $A < 90^\circ$ .

The work for the check is the same as before.

*Illustration 3.* Given:  $a=106.75$ ,  $b=276.25$ ,  $A=36^\circ 17' 36''$ .

SOLUTION

$$\sin B = \frac{b \sin A}{a}$$

$$C = 180^\circ - (A + B)$$

$$c = \frac{a \sin C}{\sin A}$$

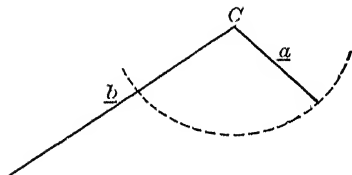


FIG. 44

$$\frac{a}{b} = 106.75 \dots \dots \text{col} = 7.97163 - 10$$

$$\frac{b}{a} = 276.25 \dots \dots \log = 2.44130$$

$$A = 36^\circ 17' 36'' \dots \log \sin = 9.77226 - 10$$

$$B = \dots \dots \dots \log \sin = 0.18519$$

Since there can be no angle with a positive logarithm of the sine, there is no solution.

## EXERCISES

Solve the triangles:

- |               |            |                       |
|---------------|------------|-----------------------|
| 1. $a=21$     | $b=23$     | $A=60^\circ$          |
| 2. $a=493.4$  | $c=264.2$  | $A=47^\circ 20'$      |
| 3. $b=7394.7$ | $c=6258.6$ | $C=67^\circ 31' 05''$ |
| 4. $b=48.815$ | $c=146.07$ | $B=12^\circ 10' 19''$ |
| 5. $a=47.688$ | $c=53.042$ | $A=43^\circ 06' 05''$ |

## GENERAL EXERCISES

Solve the triangles:

- |                           |                       |                       |
|---------------------------|-----------------------|-----------------------|
| 1. $A=57^\circ 28'$       | $C=103^\circ 45'$     | $c=248.95$            |
| 2. $B=76^\circ 24' 42''$  | $c=89.724$            | $b=41.648$            |
| 3. $a=408.34$             | $b=543.24$            | $c=765.06$            |
| 4. $C=174^\circ 43' 24''$ | $a=152.75$            | $b=19.86$             |
| 5. $a=8963.4$             | $b=4673.2$            | $c=3795.8$            |
| 6. $a=145.26$             | $b=48.48$             | $c=101.01$            |
| 7. $A=63^\circ 20' 06''$  | $b=38.052$            | $a=33.333$            |
| 8. $B=136^\circ 59' 48''$ | $C=43^\circ 00' 42''$ | $c=0.046$             |
| 9. $B=48^\circ 36'$       | $a=20.95$             | $b=25.85$             |
| 10. $C=74^\circ 54' 08''$ | $a=3.9876$            | $b=6.0934$            |
| 11. $a=2.4723$            | $b=98.7586$           | $c=97.8592$           |
| 12. $a=561.25$            | $b=687.65$            | $A=31^\circ 09' 56''$ |
| 13. $A=70^\circ 42'$      | $B=109^\circ 02'$     | $b=20.63$             |
| 14. $A=63^\circ 31' 35''$ | $a=8793.2$            | $c=9823.4$            |
| 15. $a=17.466$            | $b=9.784$             | $c=7.742$             |
| 16. $a=0.01851$           | $B=47^\circ 19' 23''$ | $c=0.01851$           |
| 17. $B=59^\circ 59' 42''$ | $c=261.27$            | $b=226.26$            |

18. From a point  $A$  on a straight road, a distant object  $C$  is observed, the line  $AC$  making an angle of  $58^\circ 30'$  with the road. From a second point  $B$  on the road, 1200 ft. from  $A$  and beyond the closest approach to  $C$ , a second observation is made, the line  $BC$  making an angle of  $63^\circ 20'$  with the road. Find  $AC$ . Find the shortest distance from  $C$  to the road.

19. It is desired to find the distance between two points  $A$  and  $B$  on opposite sides of a building. A third point  $C$  is chosen and measurements show that  $AC=126$  ft.,  $BC=173$  ft., and angle  $ACB=54^\circ 45'$ . Find  $AB$ .

20. From a point on a plain, the angle of elevation of a mountain is  $9^\circ 27'$ . From a point a mile nearer to the mountain, the angle of elevation is  $13^\circ 16'$ . How far from the first point of observation is the mountain top? How high does the mountain rise above the plain?

21. A straight tree standing on level ground leans  $20^\circ$  from the vertical, directly away from a point of observation 100 ft. from its foot. If the angle of elevation of the top of the tree from this point is  $32^\circ$ , find the length and the height of the tree.

22. A belt is stretched around two pulleys with radii of 18 in. and 30 in., respectively, the centers of which are 8 ft. apart. Find the length of the belt if crossed; if not crossed.

23. A side of a parallelogram 30 ft. long makes angles of  $23^\circ$  and  $45^\circ$  with the diagonals. Find the other side.

24. Two circles with radii of 30 in. and 25 in. intersect, and the radii drawn to one of the points of intersection meet at an angle of  $26^\circ 30'$ . Find the length of the line joining the centers of the circles.

25. Three circles with radii of 12 in., 15 in., and 25 in. are tangent externally. Find the angles between the lines joining their centers.

26. A tower 148 ft. high stands on top of a hill. From a point 1100 ft. down the hill, the tower subtends an angle of  $5^\circ 50'$ . Find the angle of inclination of the hill.

27. A line through the vertex of an equilateral triangle divides the angle into two parts which are in the ratio 3 : 5. Find the ratio in which the line divides the opposite side.

28. A lake of 1262 ft. altitude lies between two mountains of 2086 ft. altitude and 2504 ft. altitude. As observed from the summit of one mountain, the angle of depression of the reflection of the summit of the other in the lake is  $15^\circ 30'$ . Find the distance between the mountain tops.

29. Two points  $A$  and  $B$  are on opposite sides of a river. A straight line  $CD$  is run through  $A$  and the following measurements are taken:  $CA=786$  ft.,  $AD=562$  ft.,  $\angle BCA=46^\circ 50'$ ,  $\angle BDA=52^\circ 20'$ . Find  $AB$ .

30. To measure the height of an inaccessible tower  $AB$ , a line  $CD$ , which is 552.5 ft. long, is measured off in the horizontal plane through  $A$  (the foot of the tower) and the following angles are measured:  $\angle ACB=52^\circ 50'$ ,  $\angle BCD=60^\circ$ ,  $\angle CDB=47^\circ 30'$ . Find the height of the tower.

31. Two ships start from the same point, sailing at 20 mi. an hour and 12 mi. an hour, respectively, the first traveling due east and the second due northeast. Find the distance between the ships at the end of two hours' sailing.



# CHAPTER X

## AREAS

49. **Areas of Right Triangles.** The student can show that the area  $K$  of a right triangle is given by the following formulas:

$$K = \frac{1}{2}ab \quad (64)$$

$$K = \frac{1}{2}bc \sin A = \frac{1}{2}ac \sin B \quad (65)$$

$$K = \frac{1}{2}b^2 \tan A = \frac{1}{2}a^2 \tan B \quad (66)$$

$$K = \frac{1}{2}a\sqrt{(c+a)(c-a)} \quad (67)$$

Formulas 65 and 66 can be written in slightly different form by making use of the co-function relations  $\sin A = \cos B$ , etc.

Since  $a = c \sin A$  (Fig. 45)

and  $b = c \cos A$ ,

we get, from Formulas 64 and 28,

$$K = \frac{1}{2}c^2 \sin A \cos A = \frac{1}{4}c^2 \sin 2A \quad (68)$$

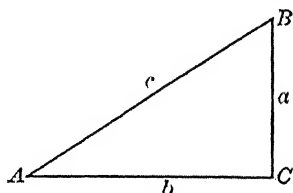


FIG. 45

### EXERCISES

Find the areas directly from the data:

- |                            |              |                            |                         |
|----------------------------|--------------|----------------------------|-------------------------|
| 1. $A = 36^\circ 42'$      | $c = 28$     | 5. $b = 46.867$            | $A = 46^\circ 53' 18''$ |
| 2. $B = 43^\circ 08'$      | $b = 8$      | 6. $a = 40$                | $c = 50$                |
| 3. $a = 652.25$            | $b = 723.48$ | 7. $a = 32,852$            | $c = 87,638$            |
| 4. $A = 19^\circ 00' 24''$ | $c = 65.575$ | 8. $B = 13^\circ 13' 13''$ | $b = 1492.1$            |

50. **Areas of Oblique Triangles.** It is convenient to be able to express the area of a triangle directly in terms of the given parts.

- (1) Given two sides  $b$  and  $c$  and the included angle  $A$ . Starting with the elementary formula

$$K = \frac{1}{2}hc \quad (69)$$

show (Fig. 46) that

$$K = \frac{1}{2}bc \sin A \quad (70)$$

$$= \frac{1}{2}ac \sin B$$

$$= \frac{1}{2}ab \sin C$$

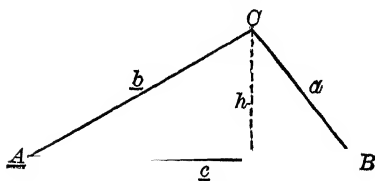


FIG. 46

(2) Given a side  $c$  and the angles.

From the law of sines (41),

$$b = \frac{c \sin B}{\sin C}$$

Hence, from (70),

$$K = \frac{c^2 \sin A \sin B}{2 \sin C} \quad (71)$$

Similarly, 
$$K = \frac{b^2 \sin A \sin C}{2 \sin B} - \frac{a^2 \sin B \sin C}{2 \sin A}$$

(3) Given the three sides.

Since, from (28),  $\sin A = 2 \sin \frac{1}{2}A \cos \frac{1}{2}A$ , (70) becomes

$$K = bc \sin \frac{1}{2}A \cos \frac{1}{2}A$$

Making use of (47) and (53), we have

$$K = \sqrt{s(s-a)(s-b)(s-c)}^* \quad (72)$$

#### EXERCISES

Find the areas of the following triangles:

- |                             |                         |                         |
|-----------------------------|-------------------------|-------------------------|
| 1. $A = 48^\circ 30'$       | $b = 342.5$             | $c = 534.8$             |
| 2. $a = 23.24$              | $b = 43.65$             | $c = 57.68$             |
| 3. $A = 54^\circ 23'$       | $B = 65^\circ 52'$      | $c = 4573.8$            |
| 4. $a = 89.04$              | $b = 71.855$            | $c = 94.347$            |
| 5. $a = 176.21$             | $B = 73^\circ 58' 06''$ | $c = 213.29$            |
| 6. $a = 42.614$             | $A = 45^\circ 48' 36''$ | $B = 61^\circ 02' 13''$ |
| 7. $b = 34.657$             | $c = 52.428$            | $A = 32^\circ 16' 17''$ |
| 8. $A = 106^\circ 42' 16''$ | $B = 42^\circ 17' 36''$ | $a = 40.265$            |
| 9. $a = 40.265$             | $b = 34.657$            | $c = 52.428$            |
| 10. $a = 210$               | $b = 142$               | $c = 68$                |

**51. The Inscribed Circle.** It is proved in plane geometry that a circle can be inscribed in any triangle. Let  $O$  (Fig. 47, page 70) be the center and  $r$  the radius of the circle inscribed in triangle  $ABC$ .

\*This formula should be familiar from plane geometry, where it is derived in an entirely different manner.

Then, since for areas

$$K = \triangle ABC = \triangle BOC + \triangle COA + \triangle AOB$$

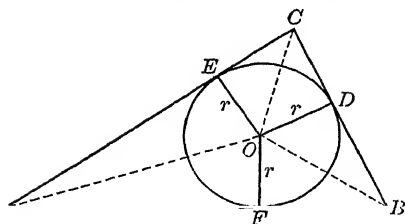


FIG. 47

and since the altitude of each of the component triangles is  $r$ , we have

$$\begin{aligned} K &= \frac{1}{2}ar + \frac{1}{2}br + \frac{1}{2}cr \\ &= \frac{1}{2}(a + b + c)r = sr \end{aligned}$$

where  $\frac{1}{2}(a + b + c) = s$ .

Hence 
$$r = \frac{K}{s} = \frac{\sqrt{s(s-a)(s-b)(s-c)}}{s}$$

or

$$r = \sqrt{\frac{(s-a)(s-b)(s-c)}{s}} \quad (73)$$

**52. The Circumscribed Circle.** It is proved in plane geometry that a circle can be circumscribed about any triangle. Let  $O$  and  $R$  represent the center and the radius, respectively, of the circle circumscribed about triangle  $ABC$  (Fig. 48).  $OD$ , being drawn perpendicular to  $a$ , bisects  $a$ . Then, since angle  $COB = 2A$ , angle  $COD = A$  and

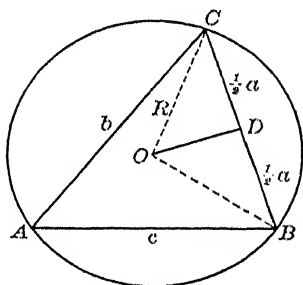


FIG. 48

$$\sin A = \frac{\frac{1}{2}a}{R} = \frac{a}{2R} \quad (74)$$

or

$$R = \frac{a}{2 \sin A} \quad 2 \sin B = \frac{b}{R} \quad 2 \sin C = \frac{c}{R} \quad (75)$$

Substitute (74) in (70):

$$K = \frac{1}{2}bc \sin A = \frac{acb}{4R}$$

or

$$R = \frac{abc}{4K} = \frac{abc}{4 \sqrt{s(s-a)(s-b)(s-c)}} \quad (76)$$

**53. The Medians of a Triangle.** In any triangle let the medians from the vertices  $A$ ,  $B$ , and  $C$  (Fig. 49) be denoted by  $m_1$ ,  $m_2$ , and  $m_3$ , respectively. Denote the angle  $ADC$  by  $t$ . Then, from the law of cosines (42),

$$b^2 = m_1^2 + \frac{1}{4}a^2 - am_1 \cos t$$

$$c^2 = m_1^2 + \frac{1}{4}a^2 - am_1 \cos(180^\circ - t)$$

$$= m_1^2 + \frac{1}{4}a^2 + am_1 \cos t.$$

Add:  $b^2 + c^2 = 2m_1^2 + \frac{1}{2}a^2$

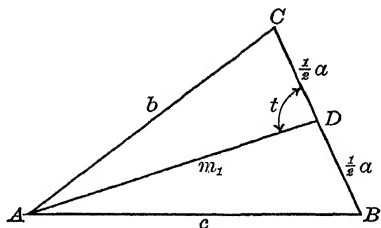


FIG. 49

or

$$m_1 = \sqrt{\frac{1}{2}(b^2 + c^2) - \frac{1}{4}a^2} \quad (77)$$

Similarly,

$$m_2 = \sqrt{\frac{1}{2}(a^2 + c^2) - \frac{1}{4}b^2}$$

$$m_3 = \sqrt{\frac{1}{2}(a^2 + b^2) - \frac{1}{4}c^2}$$

The point of intersection of the medians, which is shown by plane geometry to be two thirds of the distance from each vertex to the opposite side, is the *centroid*, or *center of gravity*, of the triangle.

**54. The Area of a Segment of a Circle.** Since the area of a circular sector is one half the product of the arc by the radius, we have (Fig. 50),

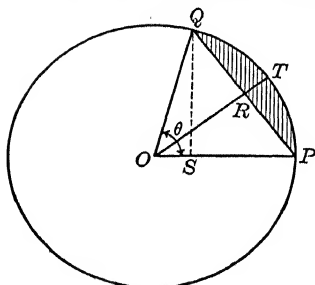


FIG. 50

$$\begin{aligned} \text{Sector } O-PTQ &= \frac{1}{2}(\text{arc } PQ)(OP) \\ &= \frac{1}{2}(OP)^2 \theta = \frac{1}{2}r^2 \theta. \end{aligned}$$

$$\begin{aligned} \text{Triangle } OPQ &= \frac{1}{2}(QP)(OR) \\ &= \frac{1}{2}(OP)(QS) \\ &= \frac{1}{2}r^2 \sin \theta. \end{aligned}$$

$$\begin{aligned} K &= \text{segment } PRQT \\ &= \frac{1}{2}r^2 \theta - \frac{1}{2}r^2 \sin \theta \end{aligned}$$

or

$$K = \frac{1}{2}r^2 (\theta - \sin \theta) \quad (78)$$

where  $\theta$  is measured in radians.

#### EXERCISES

Find the areas of the following right triangles:

- |                 |                       |                          |                       |
|-----------------|-----------------------|--------------------------|-----------------------|
| 1. $a=10$       | $c=50$                | 5. $c=300$               | $b=240$               |
| 2. $A=60^\circ$ | $c=250$               | 6. $a=89.746$            | $B=69^\circ 52' 32''$ |
| 3. $a=111.11$   | $B=24^\circ 24' 24''$ | 7. $b=0.0897$            | $B=13^\circ 26'$      |
| 4. $a=243.54$   | $c=423.56$            | 8. $A=89^\circ 23' 15''$ | $c=16.453$            |

Find the areas, the radii of the inscribed and circumscribed circles, and the lengths of the medians of the following triangles:

9.  $a=30$   $b=40$   $c=50$     11.  $a=243.5$   $b=342.6$   $c=453.4$   
 10.  $a=20$   $b=30$   $c=40$     12.  $A=50^\circ 45'$   $B=74^\circ 30'$   $c=245$

Find the areas of these triangles:

13.  $a=85.3$   $b=54.4$   $C=67^\circ 43'$   
 14.  $A=22^\circ 45'$   $B=92^\circ 30'$   $c=76.5$   
 15.  $a=89.32$   $b=72.43$   $c=60.35$   
 16.  $A=68^\circ 48' 24''$   $a=13.432$   $b=10.498$   
 17.  $a=0.9156$   $B=44^\circ 44' 44''$   $C=100^\circ 40' 48''$   
 18.  $b=0.0249$   $c=0.0193$   $A=60^\circ$   
 19.  $a=1.349$   $b=3.187$   $c=2.989$   
 20.  $A=50^\circ 20' 36''$   $a=18.087$   $c=20.453$

21. Find the area of a  $36^\circ$  sector whose arc is 12 ft.

22. Find the area of the segment cut from a circle with a radius of 6 ft. by a cord 8 ft. long.

23. A horizontal cylindrical gasoline tank 25 ft. long with a radius of 4 ft. is filled to a depth of 3 ft. How many gallons of gasoline are in it? (231 cu. in. = 1 gal.)

24. Three posts are set on level ground, their bases forming an equilateral triangle with sides 25 ft. long. If the heights of the posts are 6 ft., 15 ft., and 18 ft., find the area of the triangle formed by their tops.

25. A triangular grass plot has sides 24 ft., 30 ft., and 42.5 ft. long. Find the area of the largest circular flower bed that can be made in the plot.

26. Find the distances from the centroid to the three vertices of a triangle in which  $a=6$ ,  $b=7$ , and  $c=8$ .

27. Find the area of a parallelogram if the sides are 25 and 36 and one angle is  $58^\circ 30'$ .

## CHAPTER XI

### INVERSE FUNCTIONS AND TRIGONOMETRIC EQUATIONS

**55. Inverse Trigonometric Functions.** If we have  $y$  equal to some function of  $x$  and solve for  $x$  in terms of  $y$ , we say the new function is the *inverse* of the original. For example, the inverse of

$$(1) \quad y = x^2 \qquad \text{is} \qquad (2) \quad x = \pm \sqrt{y}.$$

In order to write the inverse of a trigonometric function such as

$$(3) \quad y = \sin x,$$

it is necessary to introduce a new type of function. We write

$$(4) \quad x = \arcsin y$$

This is read " $x$  is the angle whose sine is  $y$ ," just as (2) could be read " $x$  is the number whose square is  $y$ ." Notice that this is in accordance with (3), which states that " $y$  is the sine of the angle  $x$ ."

The expression " $\arcsin y$ " is often read "the arc sine of  $y$ " or "the antisine of  $y$ "; but the longer, more descriptive expression, "the angle whose sine is  $y$ ," is much preferred. It emphasizes the fact that *arc sin  $y$  is an angle*. Another much-used expression for " $\arcsin y$ " is " $\sin^{-1} y$ ." The  $-1$  is not an exponent in the ordinary sense of the word, but merely a symbol to indicate the inverse.

The inverses of the other trigonometric functions are indicated by  $\arccos x$ ,  $\arctan x$ , etc., or by  $\cos^{-1} x$ ,  $\tan^{-1} x$ , etc.

The inverse of a single-valued function is frequently a multiple-valued function. For example, the inverse of the single-valued function (1) is the double-valued function (2). The inverse of a trigonometric function has two principal values (angles between  $0^\circ$  and  $360^\circ$ ), each of which is associated with an infinite series of angles. For instance,  $\arcsin 2$  has the principal values of  $30^\circ$  and  $150^\circ$ , and the general values of

$n \cdot 360^\circ + 30^\circ$  and  $n \cdot 360^\circ + 150^\circ$  (in radian measure,  $2n\pi + \frac{\pi}{6}$  and  $2n\pi + \frac{5\pi}{6}$ ).

*Illustration 1.* Evaluate  $\tan(\arctan \frac{1}{2})$ .

*SOLUTION.* Since the expression in question means "the tangent of the angle whose tangent is  $\frac{1}{2}$ ," it is evident that

$$\tan(\arctan \frac{1}{2}) = \frac{1}{2}$$

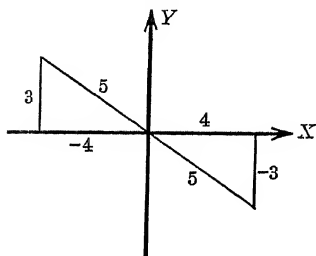


FIG. 51

*Illustration 2.* Evaluate

$$\sin(\arctan -\frac{3}{4}).$$

*SOLUTION.* Construct the principal values of  $\arctan -\frac{3}{4}$  (Fig. 51) and read the answers:

$$\sin(\arctan -\frac{3}{4}) = \frac{3}{5}, -\frac{3}{5}$$

*Illustration 3.* Verify the identity  $\arctan \frac{1}{2} + \operatorname{arccsc} \sqrt{10} = \frac{\pi}{4}$  for acute angles.

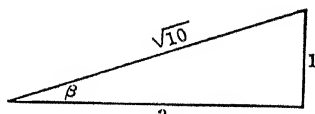
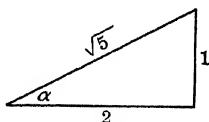


FIG. 52

*SOLUTION.* Construct the angles  $\alpha = \arctan \frac{1}{2}$  and  $\beta^* = \operatorname{arccsc} \sqrt{10}$  (Fig. 52). The identity can then be written:

$$\alpha + \beta = \frac{\pi}{4}$$

Take the tangent of both sides (sine or cosine would do as well as tangent) of the assumed equality:

$$\tan(\alpha + \beta) = \tan \frac{\pi}{4}$$

By (22):

$$\frac{\tan \alpha + \tan \beta}{1 - \tan \alpha \tan \beta} = 1$$

From Fig. 52:

$$\frac{\frac{1}{2} + \frac{1}{3}}{1 - \frac{1}{2} \cdot \frac{1}{3}} = \frac{\frac{5}{6}}{\frac{5}{6}} = 1$$

This verifies the given identity.

\*The Greek letter "beta".

## EXERCISES

Evaluate for acute given angles:

- |   |  |
|---|--|
| 1. $\sin (\operatorname{arc} \sec 3)$             | 5. $\cos (\tan^{-1} \frac{1}{2} - \tan^{-1} \frac{1}{3})$                            |
| 2. $\cos (\tan^{-1} \frac{3}{4})$                 | 6. $\tan (\frac{1}{2} \operatorname{arc} \cos \frac{2}{3})$                          |
| 3. $\cot (\operatorname{arc} \tan \frac{3}{4})$   | 7. $\sin (2 \sec^{-1} \frac{1}{2} \sqrt{5})$   |
| 4. $\sin (2 \operatorname{arc} \sin \frac{1}{2})$ | 8. $\sin (\operatorname{arc} \tan 2 + \operatorname{arc} \cos \frac{1}{2} \sqrt{5})$ |

Verify for acute angles:

9.  $\sin (\operatorname{arc} \sec \sqrt{3} + \operatorname{arc} \tan \frac{1}{2} \sqrt{2}) = 1$   
 10.  $\tan^{-1} \frac{1}{2} + \tan^{-1} \frac{1}{3} = 45^\circ$   
 11.  $\operatorname{arc} \sec \sqrt{5} - \operatorname{arc} \csc \sqrt{2} = \operatorname{arc} \cot 3$   
 12.  $\cos (\operatorname{arc} \sec 3 + \operatorname{arc} \tan \frac{1}{2}) = \frac{12 - 10\sqrt{2}}{39}$   
 13.  $\cos (2 \operatorname{arc} \tan \frac{1}{2} + \operatorname{arc} \cos \frac{1}{2}) = 0$   
 14.  $\sin (\operatorname{arc} \cos \frac{1}{2} - \operatorname{arc} \sin \frac{3}{4} - \operatorname{arc} \sin \frac{1}{4}) = \frac{1}{2}$

Hint. Write the equation thus:

$$\operatorname{arc} \cos \frac{1}{2} - \operatorname{arc} \sin \frac{3}{4} = \operatorname{arc} \sin \frac{1}{4} + \operatorname{arc} \sin \frac{1}{2}$$

Take the sine of both sides.

15.  $\operatorname{arc} \tan \frac{1}{3} + \operatorname{arc} \tan \frac{1}{2} = \operatorname{arc} \tan \frac{1}{3} + \operatorname{arc} \tan \frac{1}{4}$   
 16.  $\operatorname{arc} \tan \frac{3}{4} + \operatorname{arc} \tan \frac{1}{2} + \operatorname{arc} \sec \sqrt{10} = 180^\circ$   
 17.  $2 \sin^{-1} \frac{x}{\sqrt{2}} + \frac{\pi}{2} = \sin^{-1} (1 - x^2)$   
 18.  $2 \cot^{-1} a = \csc^{-1} \frac{1+a^2}{2a}$   
 19.  $\sec (2 \operatorname{arc} \tan a) = \frac{1+a^2}{1-a^2}$   
 20.  $\operatorname{arc} \cot 3 + \operatorname{arc} \cot 4 + \operatorname{arc} \cot 5 + \operatorname{arc} \cot 47 = (4n+1) \frac{\pi}{4}$   
 21.  $\operatorname{arc} \cot 239 = \operatorname{arc} \cot 70 - \operatorname{arc} \cot 99$   
 22.  $2 \operatorname{arc} \cot 3 + \operatorname{arc} \cot 7 = \frac{\pi}{4}$   
 23.  $\sin \left( \operatorname{arc} \tan \frac{m}{n} \right) = \cos \left( \operatorname{arc} \cot \frac{m}{n} \right)$   
 24.  $\operatorname{arc} \sin (-x) = -\operatorname{arc} \sin x$   
 25.  $\operatorname{arc} \cos (-x) = \pi - \operatorname{arc} \cos x$   
 26.  $\operatorname{arc} \tan (-x) = -\operatorname{arc} \tan x$   
 27.  $\operatorname{arc} \cos x = \frac{\pi}{2} - \operatorname{arc} \sin x$   
 28.  $\sin (\operatorname{arc} \cos x) = \sqrt{1-x^2}$   
 29.  $\cos (\operatorname{arc} \sin x) = \sqrt{1-x^2}$   
 30.  $\operatorname{arc} \sec \frac{x}{a} = \frac{\pi}{2} - \operatorname{arc} \sin \frac{x}{a}$   
 31.  $\cos (2 \operatorname{arc} \sin x) = 1 - 2x^2$   
 32.  $\operatorname{arc} \tan \frac{3}{4} = \operatorname{arc} \cos \frac{1}{5}$   
 33.  $\sin (2 \operatorname{arc} \cos x) = 2x\sqrt{1-x^2}$   
 34.  $2 \operatorname{arc} \sin \frac{3}{5} + \frac{\pi}{4} + \operatorname{arc} \cot \frac{1}{3} = 0$



**56. Trigonometric Equations.** We learned (Section 9) that an identity is true for all values of the letters involved, while an equation (of condition) is true only for one or more values of the variables in it.

An equation that involves trigonometric functions of the variables is called a **trigonometric equation**.

Since trigonometric equations can be of so many different types, a systematic discussion of even the simpler ones would require too much space to be given here. Only a few simple examples will be considered.

*Illustration 1.* Solve for  $x$ :  $3 \sin x + \cos x = 1$ .

**SOLUTION.** Write  $\sqrt{1-\sin^2 x}$  for  $\cos x$ , and rationalize:

$$\begin{aligned} 3 \sin x + \sqrt{1-\sin^2 x} &= 1 \\ \sqrt{1-\sin^2 x} &= 1-3 \sin x \\ 1-\sin^2 x &= 1-6 \sin x+9 \sin^2 x \\ 10 \sin^2 x-6 \sin x &= 0 \\ \sin x (10 \sin x-6) &= 0 \\ \sin x &= 0, \frac{3}{5} \end{aligned}$$

When  $\sin x=0$ ,  $\cos x=\pm 1$ ; and when  $\sin x=\frac{3}{5}$ ,  $\cos x=\pm \frac{4}{5}$ . Since  $\sin x=0$  and  $\cos x=-1$  will not check in the original equation, the corresponding root,  $x=180^\circ$ , must be discarded as extraneous. A second extraneous root is represented by  $x=\text{arc sin } \frac{3}{5}$  in the first quadrant. Hence there are only two proper principal-value solutions:  $x=0^\circ$  and  $x=143^\circ 07' 49''$ . The corresponding general solutions are  $n \cdot 360^\circ$ , or  $2\pi n$ , and  $n \cdot 360^\circ + 143^\circ 07' 49''$ , or  $2\pi n + 2.4981$ .

*Illustration 2.* Solve for  $x$ :  $2 \tan x + \csc 2x = 3$ .

$$\begin{aligned} \text{SOLUTION.} \quad 2 \tan x + \frac{1}{\sin 2x} &= 3 \\ \frac{2 \sin x}{\cos x} + \frac{1}{2 \sin x \cos x} &= 3 \\ \frac{4 \sin^2 x + 1}{2 \sin x \cos x} &= 3 \\ 4 \sin^2 x + 1 &= 6 \sin x \cos x \\ 4 \sin^2 x + 1 &= 6 \sin x \sqrt{1-\sin^2 x} \\ 16 \sin^4 x + 8 \sin^2 x + 1 &= 36 \sin^2 x - 36 \sin^4 x \\ 52 \sin^4 x - 28 \sin^2 x + 1 &= 0 \\ (2 \sin^2 x - 1)(26 \sin^2 x - 1) &= 0 \\ \sin x &= \pm \frac{1}{\sqrt{2}}, \pm \frac{1}{\sqrt{26}}. \end{aligned}$$

There are eight apparent principal-value solutions, four of which are extraneous, leaving  $x=45^\circ$ ,  $225^\circ$ ,  $11^\circ 18' 35''$ ,  $191^\circ 18' 35''$ . The general solutions are  $n \cdot 180^\circ + 45^\circ$  and  $n \cdot 180^\circ + 11^\circ 18' 35''$ .

## EXERCISES

Solve for  $x$  and check, discarding any extraneous roots:

1.  $2 \sin^2 x - \cos^2 x + \frac{1}{4} = 0$
2.  $3 \sin x + 2 \cos x = 3$
3.  $\cos x - \sqrt{3} \sin x + 1 = 0$
4.  $2 \cos^2 2x + \cos 2x - 1 = 0$
5.  $\sin 5x - \sin 3x + \sin x = 0$
6.  $\sin 5x + \sin 3x + \cos x = 0$
7.  $\arctan x + \arctan (1-x) = \arctan \frac{1}{3}$
8.  $\arctan \frac{2x}{1-x^2} = \frac{\pi}{3}$
9.  $\arctan \frac{x-1}{x+2} + \arctan \frac{x+1}{x+2} = \frac{\pi}{4}$
10.  $\arccos x = \arccos a - \arccos b$
11.  $\arccos x - \arccos \sqrt{1-x^2} = \arccos \sqrt{3} x$
12.  $\arccos x = \frac{\pi}{2} - \arcsin \sqrt{1-x^2}$
13.  $\arcsin x + \arcsin 2x = \frac{\pi}{2}$
14.  $\arcsin 3x - \arcsin x = \frac{\pi}{3}$
15.  $\arctan 3x + \arctan 2x = \frac{\pi}{4}$
16.  $\arctan x = \frac{1}{2} \arcsin x$
17.  $\arcsin x - \arccos x = \frac{\pi}{2}$
18.  $\arcsin 2x - \arccos x = \frac{\pi}{6}$
19.  $\tan^{-1} x + \cot^{-1} \frac{1+x}{2-x} = \tan^{-1} 2$
20.  $\cot^{-1} x + \tan^{-1} 2 = \tan^{-1} \frac{2x+1}{x-2}$

Solve the following systems for  $x$  and  $y$ :

21.  $\begin{cases} y = \sin x \\ y = \sin \left(x + \frac{\pi}{3}\right) \end{cases}$
22.  $\begin{cases} y = 3 \sin x \\ y = 3 \cos x \end{cases}$
23.  $\begin{cases} y = \sec x \\ y(1 + \cos x) = 3 \end{cases}$

Find the principal-value solutions:

24.  $\begin{cases} y = 3 \sin x + 2 \cos x \\ y = 3 \cos x + 2 \sin x \end{cases}$
25.  $6 \sin x - 4 \cos x = 3$
26.  $2 \tan x + \sec x = 3$

Transform the following equations into algebraic expressions which do not involve trigonometric functions:

27.  $\arcsin x + \arcsin y = \frac{\pi}{2}$
28.  $\arcsin x + \arcsin y = \frac{\pi}{3}$
29.  $\arcsin x + 2 \arcsin y = \pi$
30.  $\arctan x + \arctan y = \frac{\pi}{4}$
31.  $\arctan x - \arctan y = \frac{\pi}{4}$
32.  $\arctan x + 2 \arctan y = \pi$

## CHAPTER XII

### THE IMAGINARY IN TRIGONOMETRY

#### 57. Trigonometric Representation of a Complex Number.

In algebra, a complex number  $x+iy$ , where  $i=\sqrt{-1}$ , is represented by a point  $P$  in the so-called "complex plane." The

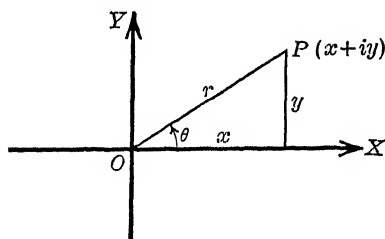


FIG. 53

line  $OP=r$  (Fig. 53), connecting the point with the origin, is called the *radius vector* of the point; and the angle  $O$ , measured in a counterclockwise direction from the positive  $X$ -axis to the radius vector, is called the *amplitude*.

From Fig. 53:  $x=r \cos \theta$

$$iy = ir \sin \theta$$

Add:  $x+iy = r(\cos \theta + i \sin \theta)$  (79)

**58. Multiplication of Complex Numbers.** Let us form the product of two complex numbers:

$$x_1+iy_1=r_1(\cos \theta_1+i \sin \theta_1)$$

$$x_2+iy_2=r_2(\cos \theta_2+i \sin \theta_2)$$

$$(x_1+iy_1)(x_2+iy_2)=r_1r_2(\cos \theta_1 \cos \theta_2 + i \sin \theta_1 \cos \theta_2 + i \cos \theta_1 \sin \theta_2 - \sin \theta_1 \sin \theta_2).$$

Collect the real and the imaginary parts of the right-hand member:

$$(x_1+iy_1)(x_2+iy_2)=r_1r_2[\cos \theta_1 \cos \theta_2 - \sin \theta_1 \sin \theta_2 + i(\sin \theta_1 \cos \theta_2 + \cos \theta_1 \sin \theta_2)]$$

or  $(x_1+iy_1)(x_2+iy_2)=r_1r_2[\cos (\theta_1+\theta_2)+i \sin (\theta_1+\theta_2)]$

If  $x_3+iy_3=r_3(\cos \theta_3+i \sin \theta_3)$  is a third complex number, it is readily seen that:

$$(x_1+iy_1)(x_2+iy_2)(x_3+iy_3)=r_1r_2r_3[\cos (\theta_1+\theta_2+\theta_3)+i \sin (\theta_1+\theta_2+\theta_3)]$$

It may be proved by mathematical induction that the product of  $n$  complex numbers is:

$$(x_1 + iy_1)(x_2 + iy_2) \cdots (x_n + iy_n) \\ = r_1 r_2 \cdots r_n [\cos (\theta_1 + \theta_2 + \cdots + \theta_n) + i \sin (\theta_1 + \theta_2 + \cdots + \theta_n)] \quad (80)$$

**59. De Moivre's Theorem.** Suppose in (80) that all the complex numbers are equal. It follows that

$$\begin{array}{ll} (1) & x_1 = x_2 = \cdots = x_n \\ (2) & y_1 = y_2 = \cdots = y_n \\ (3) & \theta_1 = \theta_2 = \cdots = \theta_n \\ (4) & r_1 = r_2 = \cdots = r_n \end{array}$$

Designate these common values of (1) by  $x$ , of (2) by  $y$ , of (3) by  $\theta$ , and of (4) by  $r$ . Then (80) becomes:

$$(x + iy)^n = r^n (\cos n\theta + i \sin n\theta)$$

But simply raising both members of (79) to the  $n$ th power gives

$$(x + iy)^n = r^n (\cos \theta + i \sin \theta)^n$$

Equate these two values of  $(x + iy)^n$  and cancel the common factor  $r^n$ :

$$(\cos \theta + i \sin \theta)^n = \cos n\theta + i \sin n\theta \quad (81)$$

This last important expression is known as *De Moivre's Theorem*. In the above derivation it is assumed that  $n$  is a positive integer. It is easily proved in calculus that De Moivre's Theorem is true when  $n$  is any number.

*Illustration 1.* Develop De Moivre's Theorem for  $\theta = 30^\circ$ ,  $n = 3$ .

$$\begin{array}{ll} \text{SOLUTION.} & (\cos 30^\circ + i \sin 30^\circ)^3 = \cos 90^\circ + i \sin 90^\circ \\ \text{or} & (\frac{1}{2}\sqrt{3} + \frac{1}{2}i)^3 = i \end{array}$$

The student may verify the above by expanding the left-hand member.

*Illustration 2.* By means of De Moivre's Theorem, derive the formulas for  $\sin 2\theta$  and  $\cos 2\theta$ .

*SOLUTION.* In (81), let  $n = 2$ .

$$\begin{array}{l} \text{Then} \quad (\cos \theta + i \sin \theta)^2 = \cos 2\theta + i \sin 2\theta \\ \text{Equate the right-hand member to the left-hand member expanded:} \\ \cos 2\theta + i \sin 2\theta = \cos^2 \theta + 2i \sin \theta \cos \theta - \sin^2 \theta \end{array}$$

But a theorem in algebra states that

*If two complex numbers are equal, their real terms are equal and their imaginary terms are equal.*

$$\text{Hence} \quad \cos 2\theta = \cos^2 \theta - \sin^2 \theta \quad \sin 2\theta = 2 \sin \theta \cos \theta$$

*Illustration 3.* Express the roots of  $z^2 - 2z + 4 = 0$  in trigonometric form.

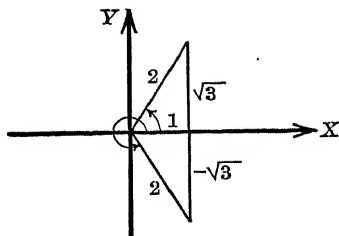


FIG. 54

## SOLUTION

The roots are

$$z = 1 + \sqrt{3}i \quad \text{and} \quad z = 1 - \sqrt{3}i$$

When plotted (Fig. 54), we see that  $r_1 = r_2 = 2$ ,  $\theta_1 = 60^\circ$ ,  $\theta_2 = 300^\circ$ . Hence the roots may be written:

$$z_1 = 2 (\cos 60^\circ + i \sin 60^\circ)$$

$$\text{and } z_2 = 2 (\cos 300^\circ + i \sin 300^\circ) \\ = 2 (\cos 60^\circ - i \sin 60^\circ)$$

*Illustration 4.* Cube  $(3+4i)$ .

*SOLUTION.* If we plot the number  $3+4i$  (Fig. 55), we see that  $r=5$  and

that  $\theta = \arctan \frac{4}{3}$  is in the first quadrant. Reference to a table shows that  $\theta = 53^\circ 07' 45''$ .

Hence  $3+4i = 5 (\cos \theta + i \sin \theta)$ , and  $(3+4i)^3 = 125 (\cos \theta + i \sin \theta)^3 = 125 (\cos 3\theta + i \sin 3\theta) = 125 (\cos 159^\circ 23' 15'' + i \sin 159^\circ 23' 15'')$ .

Use logarithmic computation:

$$\begin{array}{rcl} 125 & \dots\dots\dots \log = 2.09691 & \dots\dots\dots \log = 2.09691 \\ 159^\circ 23' 15'' & \dots\dots \log \cos = 9.97127 - 10n & \dots\dots \log \sin = 9.54660 - 10 \\ -117 & \dots\dots\dots \log = 2.06818n & \\ \hline 44.006 & \dots\dots\dots & \dots\dots \log = 1.64351 \end{array}$$

The answer appears to be  $-117 + 44.006i$ . Since from the nature of the problem both  $x$  and  $y$  must be integers, the correct answer must be  $-117 + 44i$ . The slight error in the imaginary part is due to the fact that the tables are at best but approximations.

The student should check the answer by direct calculation.

Notice that the trigonometric method is longer than direct calculation in the case at hand; but this is not true when the power is large or fractional.

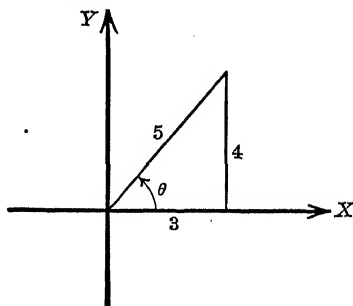


FIG. 55

## EXERCISES

1. By means of De Moivre's Theorem evaluate:

(a)  $(\cos 45^\circ + i \sin 45^\circ)^6$

(b)  $(\cos 10^\circ + i \sin 10^\circ)^3$

(c)  $(\cos 13^\circ + i \sin 13^\circ)^6$

2. Derive formulas for  $\sin 3\theta$ ,  $\cos 3\theta$ ,  $\sin 4\theta$ , and  $\cos 4\theta$ .

3. Write in algebraic form:

(a)  $\cos 60^\circ + i \sin 60^\circ$

(b)  $\sqrt{2}(\cos 135^\circ + i \sin 135^\circ)$

(c)  $3(\cos 120^\circ + i \sin 120^\circ)$

4. Write in trigonometric form:

- (a)  $2-2i$  (c)  $8$  (e)  $2-i$  (g)  $2-\sqrt{3}i$   
 (b)  $\sqrt{3}+i$  (d)  $-4i$  (f)  $3+4i$  (h)  $(\sqrt{6}+\sqrt{2})+(\sqrt{6}-\sqrt{2})i$

5. Express the roots of the following equations in trigonometric form:

- (a)  $2z^2+2z+1=0$  (d)  $z^2+\sqrt{3}z+1=0$  (g)  $z^2+7=0$   
 (b)  $z^2+1=0$  (e)  $z^2+2z+1=0$  (h)  $z^2+z+\frac{5}{2}=0$   
 (c)  $5z^2-2z+2=0$  (f)  $z^2-\sqrt{2}z+1=0$  (i)  $z^3-1=0$

6. Raise to the indicated powers by De Moivre's Theorem:

- (a)  $(\frac{1}{2}+\frac{1}{2}\sqrt{3}i)^3$  (c)  $(-1-i)^{10}$  (e)  $(\sqrt{3}-i)^{15}$   
 (b)  $(-\frac{1}{2}\sqrt{3}+\frac{1}{2}i)^4$  (d)  $(3-5i)^{\frac{5}{2}}$  (f)  $(2+i)^{10}$

**60. The Roots of a Complex Number.** We have proved De Moivre's Theorem

$$(\cos \varphi + i \sin \varphi)^n = \cos n\varphi + i \sin n\varphi^{**}$$

where  $n$  is a positive integer. Take the  $n$ th root of each side:

$$\cos \varphi + i \sin \varphi = (\cos n\varphi + i \sin n\varphi)^{\frac{1}{n}}$$

If we let  $n\varphi = \theta$ , or  $\varphi = \frac{\theta}{n}$ , this becomes

$$(\cos \theta + i \sin \theta)^{\frac{1}{n}} = \cos \frac{\theta}{n} + i \sin \frac{\theta}{n} \quad (82)$$

This is merely De Moivre's theorem with the reciprocal of a positive integer for exponent.

Since  $360^\circ$  or an integral multiple of  $360^\circ$  can be added to an angle without changing the value of its trigonometric functions,

$$\cos \theta + i \sin \theta = \cos (\theta + 360^\circ k) + i \sin (\theta + 360^\circ k)$$

where  $k$  is zero or a positive integer.

Hence (82) may be written thus:

$$(\cos \theta + i \sin \theta)^{\frac{1}{n}} = \cos \frac{\theta + 360^\circ k}{n} + i \sin \frac{\theta + 360^\circ k}{n}$$

Make use of (79):

$$\sqrt[n]{x + iy} = \sqrt[n]{r} \left[ \cos \frac{\theta + 360^\circ k}{n} + i \sin \frac{\theta + 360^\circ k}{n} \right] \quad (83)$$

\*Assume De Moivre's Theorem true for fractional exponents.

\*\*The Greek letter "phi."

This formula permits us to extract any root of any number.  $\sqrt[n]{r}$  means simply the arithmetic root of  $r = \sqrt{x^2 + y^2}$ .

The angle  $\theta = \arctan \frac{y}{x}$  can best be obtained by plotting the number  $x + iy$ . For a real number,  $y = 0$ ; and for a pure imaginary number,  $x = 0$ .

*Illustration 1.* Extract the three cube roots of  $i$ .

*SOLUTION.* In this case  $r = 1$ ,  $\theta = 90^\circ$ ,  $n = 3$ , and (83) becomes

$$\sqrt[3]{i} = \cos \frac{90^\circ + 360^\circ k}{3} + i \sin \frac{90^\circ + 360^\circ k}{3}$$

Designate the three desired roots by  $R_1$ ,  $R_2$ , and  $R_3$ . Then:

$$\text{If } k = 0, R_1 = \cos 30^\circ + i \sin 30^\circ = \frac{1}{2}\sqrt{3} + \frac{1}{2}i.$$

$$\text{If } k = 1, R_2 = \cos 150^\circ + i \sin 150^\circ = -\frac{1}{2}\sqrt{3} + \frac{1}{2}i.$$

$$\text{If } k = 2, R_3 = \cos 270^\circ + i \sin 270^\circ = -i.$$

If  $k = 3$ , we get  $R_1$  again, etc.

*Illustration 2.* Extract the four fourth roots of  $\sqrt{3} - i$ .

*SOLUTION.* In this case  $r = 2$ ,  $\theta = 330^\circ$  (Fig. 57), and (83) becomes

$$\sqrt[4]{\sqrt{3} - i} = \sqrt[4]{2} \left[ \cos \frac{330^\circ + 360^\circ k}{4} + i \sin \frac{330^\circ + 360^\circ k}{4} \right]$$

Letting  $k = 0, 1, 2, 3$ , respectively, we get:

$$R_1 = \sqrt[4]{2} (\cos 82^\circ 30' + i \sin 82^\circ 30') \\ = 0.15523 + 1.1791i$$

$$R_2 = \sqrt[4]{2} (\cos 172^\circ 30' + i \sin 172^\circ 30') \\ = -1.1791 + 0.15523i$$

$$R_3 = \sqrt[4]{2} (\cos 262^\circ 30' + i \sin 262^\circ 30') \\ = -0.15523 - 1.1791i$$

$$R_4 = \sqrt[4]{2} (\cos 352^\circ 30' + i \sin 352^\circ 30') \\ = 1.1791 - 0.15523i$$

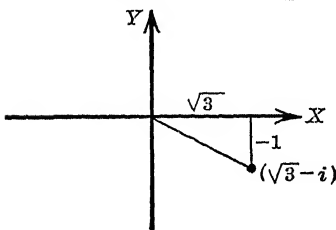


FIG. 57

The final numerical values are, of course, only approximations, correct to four or five places.

#### EXERCISES

Extract the following roots:

1. Cube roots of 1
2. Fourth roots of  $-8 - 8\sqrt{3}i$
3. Fourth roots of  $-1 + \sqrt{3}i$
4. Cube roots of  $-1 + \sqrt{3}i$
5. Sixth roots of  $-1$
6. Fourth roots of  $3 + i$
7. Fourth roots of  $-7 - 7i$
8. Fifth roots of  $2 - 5\sqrt{3}i$
9. Cube roots of  $-11 + 2i$
10. Cube roots of  $\sqrt{3} - i$

**61. The Trigonometric Functions as Power Series.** Expand the right-hand member of the following equation by the binomial theorem:

$$\cos n\theta + i \sin n\theta = (\cos \theta + i \sin \theta)^n$$

$$\begin{aligned} \cos n\theta + i \sin n\theta = & \cos^n \theta + i n \cos^{n-1} \theta \sin \theta - \frac{n(n-1)}{2!} \cos^{n-2} \theta \sin^2 \theta \\ & - i \frac{n(n-1)(n-2)}{3!} \cos^{n-3} \theta \sin^3 \theta \\ & + \frac{n(n-1)(n-2)(n-3)}{4!} \cos^{n-4} \theta \sin^4 \theta + \dots \end{aligned}$$

Equate the real parts and the imaginary parts:

$$\begin{aligned} \cos n\theta = & \cos^n \theta - \frac{n(n-1)}{2!} \cos^{n-2} \theta \sin^2 \theta \\ & + \frac{n(n-1)(n-2)(n-3)}{4!} \cos^{n-4} \theta \sin^4 \theta - \dots \end{aligned}$$

$$\sin n\theta = n \cos^{n-1} \theta \sin \theta - \frac{n(n-1)(n-2)}{3!} \cos^{n-3} \theta \sin^3 \theta + \dots$$

Now let  $n\theta = x$ . Then  $n = \frac{x}{\theta}$ ; also

$$\begin{aligned} \cos x = & \cos^n \theta - \frac{\frac{x}{\theta} \left( \frac{x}{\theta} - 1 \right)}{2!} \cos^{n-2} \theta \sin^2 \theta \\ & + \frac{\frac{x}{\theta} \left( \frac{x}{\theta} - 1 \right) \left( \frac{x}{\theta} - 2 \right) \left( \frac{x}{\theta} - 3 \right)}{4!} \cos^{n-4} \theta \sin^4 \theta - \dots \end{aligned}$$

$$\sin x = \frac{x}{\theta} \cos^{n-1} \theta \sin \theta - \frac{\frac{x}{\theta} \left( \frac{x}{\theta} - 1 \right) \left( \frac{x}{\theta} - 2 \right)}{3!} \cos^{n-3} \theta \sin^3 \theta + \dots$$

These expressions may be written:

$$\begin{aligned} \cos x = & \cos^n \theta - \frac{x(x-\theta)}{2!} \cos^{n-2} \theta \left( \frac{\sin \theta}{\theta} \right)^2 \\ & + \frac{x(x-\theta)(x-2\theta)(x-3\theta)}{4!} \cos^{n-4} \theta \left( \frac{\sin \theta}{\theta} \right)^4 - \dots \\ \sin x = & x \cos^{n-1} \theta \frac{\sin \theta}{\theta} - \frac{x(x-\theta)(x-2\theta)}{3!} \cos^{n-3} \theta \left( \frac{\sin \theta}{\theta} \right)^3 + \dots \end{aligned}$$

\*The expression  $n!$  is read "factorial  $n$ " and equals  $1 \cdot 2 \cdot 3 \cdot 4 \cdot \dots \cdot n$ . In particular,  $4! = 1 \cdot 2 \cdot 3 \cdot 4 = 24$ . Another frequently used notation is  $[n]$ .



Now let  $\theta \rightarrow 0$  while  $x$  remains finite. Then  $n = \frac{x}{\theta}$ . We know that  $\cos 0 = 1$  and  $\lim_{\theta \rightarrow 0} \frac{\sin \theta}{\theta} = 1$ . (See Formula 12.) It is true that the limits as  $\theta \rightarrow 0$  of  $\cos^n \theta$  and  $\left(\frac{\sin \theta}{\theta}\right)^n$  are both 1.\*

The above equations then become

$$\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \frac{x^8}{8!} - \dots \quad (84)$$

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \frac{x^9}{9!} - \dots \quad (85)$$

The convergence of these series is proved in algebra. It is of course necessary to measure  $x$  in radians.

**62. Euler's\*\* Equations.** There is an important constant in mathematics, the base of the Napierian or natural system of logarithms, which is denoted by  $e$  and defined by the following equation:

$$e = \lim_{n \rightarrow \infty} \left(1 + \frac{1}{n}\right)^n \quad (86)$$

Raising both sides to the power  $x$ , we get

$$e^x = \lim_{n \rightarrow \infty} \left(1 + \frac{1}{n}\right)^{nx}$$

By the binomial theorem:

$$\begin{aligned} \left(1 + \frac{1}{n}\right)^{nx} &= 1 + nx \frac{1}{n} + \frac{nx(nx-1)}{2!} \frac{1}{n^2} + \frac{nx(nx-1)(nx-2)}{3!} \frac{1}{n^3} + \\ &= 1 + x + \frac{x\left(x - \frac{1}{n}\right)}{2!} + \frac{x\left(x - \frac{1}{n}\right)\left(x - \frac{2}{n}\right)}{3!} + \dots \end{aligned}$$

Take the limits as  $n \rightarrow \infty$ :

$$= 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \frac{x^5}{5!} + \dots \quad (87)$$

$$e = 1 + 1 + \frac{1}{2!} + \frac{1}{3!} + \frac{1}{4!} + \frac{1}{5!} + \dots = 2.71828 \dots *** \quad (88)$$

\*The rigorous proof of these facts is beyond the scope of this work. They are easily proved by methods of the calculus.

\*\*Euler is pronounced "Oiler."

\*\*\*See Section 10.

If in (87) we substitute  $i\theta$  and  $-i\theta$  in turn for  $x$ , we get, respectively, after collecting real and imaginary parts,

$$e^{i\theta} = \left(1 - \frac{\theta^2}{2!} + \frac{\theta^4}{4!} - \cdots\right) + i\left(\theta - \frac{\theta^3}{3!} + \frac{\theta^5}{5!} - \cdots\right)$$

$$e^{-i\theta} = \left(1 - \frac{\theta^2}{2!} + \frac{\theta^4}{4!} - \cdots\right) - i\left(\theta - \frac{\theta^3}{3!} + \frac{\theta^5}{5!} - \cdots\right)$$

Making use of (84) and (85), we get

$$e^{i\theta} = \cos \theta + i \sin \theta \qquad e^{-i\theta} = \cos \theta - i \sin \theta \qquad (89)$$

By first adding and then subtracting the two equations in (89), we get

$$\cos \theta = \frac{e^{i\theta} + e^{-i\theta}}{2} \qquad \sin \theta = \frac{\theta - e^{-i\theta}}{2i} \qquad (90)$$

The equations in (90) are known as Euler's Equations, and are very useful in mathematics. It is possible to start with the equations in (90) as the definitions of the sine and the cosine and to develop the whole science of trigonometry without reference to an angle. The other functions would then be defined thus:

$$\tan \theta = \frac{\sin \theta}{\cos \theta} \qquad \cot \theta = \frac{\cos \theta}{\sin \theta}, \text{ etc.}$$

#### EXERCISES

1. Express  $\tan \theta$ ,  $\cot \theta$ ,  $\sec \theta$ , and  $\csc \theta$  in exponential form.

Verify, using the exponential values of the functions:

2.  $\sin^2 \theta + \cos^2 \theta = 1$

$$\begin{aligned} \text{SOLUTION.} \quad \sin^2 \theta + \cos^2 \theta &= \left(\frac{e^{i\theta} - e^{-i\theta}}{2i}\right)^2 + \left(\frac{e^{i\theta} + e^{-i\theta}}{2}\right)^2 \\ &= \frac{\theta - 2 + e^{-2i\theta}}{-4} + \frac{e^{2i\theta} + 2 + e^{-2i\theta}}{4} \\ &= \frac{-e^{2i\theta} + 2 - e^{-2i\theta} + e^{2i\theta} + 2 + e^{-2i\theta}}{4} = 1 \end{aligned}$$

3.  $\sec^2 \theta - \tan^2 \theta = 1$

5.  $\sin 2x = 2 \sin x \cos x$

4.  $\csc^2 \theta - \cot^2 \theta = 1$

6.  $2 \sin^2 x = 1 - \cos 2x$

7.  $\sin(x+y) = \sin x \cos y + \cos x \sin y$

8.  $\cos(x-y) = \cos x \cos y + \sin x \sin y$

9.  $\sin 3x = 3 \sin x - 4 \sin^3 x$

10. Show that  $e^{\frac{\pi i}{2}} = i$ , hence  $\sqrt{i} = e^{\frac{\pi}{4}}$ . HINT. Use (89).
11. Prove: (a)  $e^{\frac{\pi i}{4}} = \frac{1}{2}\sqrt{2}(1+i)$ ; (b)  $e^{\frac{-\pi i}{4}} = \frac{1}{2}(1-\sqrt{2}i)$
12. Express in algebraic form: (a)  $e^{\pi i}$ ; (b)  $e^{\frac{2\pi i}{3}}$ ; (c)  $e^{-\pi i}$ ; (d)  $e^{\frac{-\pi i}{2}}$
13. Write in exponential form: (a)  $\cos 30^\circ + i \sin 30^\circ$ ; (b)  $\sqrt{3} + i$ ;  
 (c)  $\frac{-1+\sqrt{3}i}{2}$ ; (d)  $\frac{1+i}{\sqrt{2}}$

**63. Hyperbolic Functions.** It has been pointed out that the trigonometric functions, or *circular functions*, as they are often called, can be defined by the relations in Formula 90. Another set of rather useful functions, called *hyperbolic functions*, is defined by the following analogous relations:

$$\sinh x = \frac{e^x - e^{-x}}{2} \qquad \cosh x = \frac{e^x + e^{-x}}{2} \qquad (91)$$

These functions are read "the hyperbolic sine of  $x$ ," etc. The other functions may be defined thus:

$$\begin{aligned} \tanh x &= \frac{\sinh x}{\cosh x} = \frac{e^x - e^{-x}}{e^x + e^{-x}} & \operatorname{sech} x &= \frac{1}{\cosh x} = \frac{2}{e^x + e^{-x}} \\ \coth x &= \frac{\cosh x}{\sinh x} = \frac{e^x + e^{-x}}{e^x - e^{-x}} & \operatorname{csch} x &= \frac{1}{\sinh x} = \frac{2}{e^x - e^{-x}} \end{aligned}$$

It should be noted that  $x$  is *not an angle*.

It can be shown that the hyperbolic functions are related to the rectangular hyperbola  $x^2 - y^2 = 1$  in a manner somewhat analogous to the way in which the circular functions are related to the unit circle  $x^2 + y^2 = 1$ .

#### EXERCISES

1. In Formula 90 and similar expressions for the other circular functions, replace  $\theta$  by  $ix$  and thus show that:

- (a)  $\sin ix = i \sinh x$       (c)  $\tan ix = i \tanh x$       (e)  $\sec ix = \operatorname{sech} x$   
 (b)  $\cos ix = \cosh x$       (d)  $\cot ix = -i \coth x$       (f)  $\csc ix = -i \operatorname{csch} x$

2. Show that:

- (a)  $i \sin x = \sinh ix$       (c)  $i \tan x = \tanh ix$       (e)  $\check{\sec} x = \operatorname{sech} ix$   
 (b)  $\cos x = \cosh ix$       (d)  $\cot x = i \coth ix$       (f)  $\csc x = i \operatorname{csch} ix$

Verify the following identities:

3.  $\cosh^2 x - \sinh^2 x = 1$

FIRST SOLUTION. In the fundamental identity  $\sin^2 \theta + \cos^2 \theta = 1$ , let  $\theta = ix$ , giving  $\sin^2 ix + \cos^2 ix = 1$ . Now use the results of ex. 1 above.

SECOND SOLUTION. From Formula 91,

$$\cosh^2 x - \sinh^2 x = \frac{(e^x + e^{-x})^2}{4} - \frac{(e^x - e^{-x})^2}{4} = 1$$

4.  $\operatorname{sech}^2 x + \tanh^2 x = 1$

5.  $\coth^2 x - \operatorname{csch}^2 x = 1$

6.  $\sinh 2x = 2 \sinh x \cosh x$

7.  $\cosh 2x = \cosh^2 x + \sinh^2 x$

8.  $\tanh 2x = \frac{2 \tanh x}{1 + \tanh^2 x}$

9.  $\sinh(-x) = -\sinh x$

10.  $\cosh(-x) = \cosh x$

11.  $\sinh(x+y) = \sinh x \cosh y + \cosh x \sinh y$

12.  $\sinh(x-y) = \sinh x \cosh y - \cosh x \sinh y$

13.  $\cosh(x+y) = \cosh x \cosh y + \sinh x \sinh y$

14.  $\cosh(x-y) = \cosh x \cosh y - \sinh x \sinh y$

15.  $\cosh x + \sinh x = e^x$

16.  $\cosh x - \sinh x = e^{-x}$

17.  $\sinh x = x + \frac{x^3}{3!} + \frac{x^5}{5!} + \frac{x^7}{7!} + \cdots$

18.  $\cosh x = 1 + \frac{x^2}{2!} + \frac{x^4}{4!} + \frac{x^6}{6!} + \cdots$

**64. Inverse Hyperbolic Functions.** The inverse of  $y = \sinh x$  is written  $x = \sinh^{-1} y$ , just as the inverse of  $y = \sin x$  may be written  $x = \sin^{-1} y$ . Notice that the symbol  $\operatorname{arcsinh} y$  cannot be used, since  $\sinh^{-1} y$  is not an angle or an arc. The expression  $\sinh^{-1} y$  is read "the inverse hyperbolic sine of  $y$ " or "the function whose hyperbolic sine is  $y$ ." There is, of course, similar notation for the inverses of the other five hyperbolic functions.

#### EXERCISES

1. Verify the identity:  $\sinh^{-1} x = \log(x + \sqrt{x^2 + 1})$

SOLUTION. Let  $y = \sinh^{-1} x$ . Then  $x = \sinh y = \frac{e^y - e^{-y}}{2}$

$$2x = e^y - e^{-y} = e^y - \frac{1}{e^y}$$

$$2xe^y = e^{2y} - 1, \text{ or } e^{2y} - 2xe^y - 1 = 0$$

$$\text{Solve as a quadratic in } e^y: e^y = \frac{2x \pm \sqrt{4x^2 + 4}}{2} = x \pm \sqrt{x^2 + 1}$$

Take  $\log_e$  of each member:  $y = \log_e(x \pm \sqrt{x^2 + 1})$

The negative sign may be excluded, since for  $x$  real  $x - \sqrt{x^2 + 1}$  is negative and the logarithm of a negative number is imaginary.

Verify the following identities:

$$2. \cosh^{-1} x = \log_e (x + \sqrt{x^2 - 1})$$

$$3. \tanh^{-1} x = \frac{1}{2} \log_e \frac{1+x}{1-x}$$

$$4. \operatorname{sech}^{-1} x = \cosh^{-1} \frac{1}{x} = \log_e \frac{1 + \sqrt{1-x^2}}{x}$$

$$5. \coth^{-1} x = \frac{1}{2} \log_e \frac{x+1}{x-1}$$

$$6. \operatorname{csch}^{-1} x = \log_e \frac{1 + \sqrt{1+x^2}}{x}$$

$$7. \sinh \frac{\pi i}{2} = i, \quad \cosh \frac{\pi i}{2} = 0$$

$$8. \sin^{-1} ix = i \sinh^{-1} x$$

$$9. \cos^{-1} x = i \cosh^{-1} x$$

$$10. \tan^{-1} ix = i \tanh^{-1} x$$

$$11. \cot^{-1} ix = -i \coth^{-1} x$$

$$12. \sec^{-1} x = i \operatorname{sech}^{-1} x$$

$$13. \csc^{-1} ix = -i \operatorname{csch}^{-1} x$$

# SPHERICAL TRIGONOMETRY

## CHAPTER XIII

### THE SPHERICAL TRIANGLE

**65. Spherical Geometry.** The following definitions and theorems are quoted for review from solid geometry.

A *great circle* is the section cut from a sphere by a plane passing through the center of the sphere. The section cut by a plane not passing through the center is called a *small circle*.

The *distance* between two points on the surface of a sphere is the shorter arc of the great circle that joins them.

The *poles* of a circle on a sphere are the ends of the diameter of the sphere that is perpendicular to the plane of the circle. The distance from a point of a circle to its nearer pole is called the *polar distance* of the circle.

The *angle between two circles* on a sphere is the angle formed by the tangents to the circles at a point of intersection.

A *lune* is that part of the surface of a sphere bounded by two semicircumferences of great circles.

A *spherical triangle* is a part of the surface of a sphere bounded by three arcs of great circles.

The angles and the sides of a spherical triangle will be denoted by  $A, B, C$  and  $a, b, c$ , respectively. The sides, being arcs of great circles and hence measured by their subtended central angles, are measured in degrees or in radians.

If the vertices of a triangle  $T$  are the poles of the sides of a triangle  $T'$ , then  $T'$  is called the *polar triangle* of  $T$ .

### THEOREMS

In any spherical triangle,

- I. *Each side is less than the sum of the other two sides.*
- II. *Any side or angle is less than  $180^\circ$ .*
- III. *The sum of the sides is less than  $360^\circ$ .*

IV. The sum of the angles lies between  $180^\circ$  and  $540^\circ$ .

V. The order of magnitude of the angles is the same as that of the respective opposite sides.

VI. If  $T'$  is the polar triangle of  $T$ , then  $T$  is the polar triangle of  $T'$ .

VII. In two polar triangles, each angle of one is the supplement of the opposite side of the other. That is,

$$\begin{array}{lll} A + a' = 180^\circ & B + b' = 180^\circ & C + c' = 180^\circ \\ A' + a = 180^\circ & B' + b = 180^\circ & C' + c = 180^\circ \end{array}$$

VIII. The area of a spherical triangle is  $\pi R^2 \frac{E}{180^\circ}$ , where  $R$  is

the radius of the sphere and  $E = A + B + C - 180^\circ$  is the spherical excess of the triangle.

It follows from IV that a spherical triangle can have one, two, or three right angles or obtuse angles.

66. The Law of Sines. In any spherical triangle,

The sines of the angles are proportional to the sines of the opposite sides.

That is, 
$$\frac{\sin A}{\sin a} = \frac{\sin B}{\sin b} = \frac{\sin C}{\sin c} \quad (92)$$

PROOF. Let  $ABC$  be any spherical triangle (Fig. 58). From

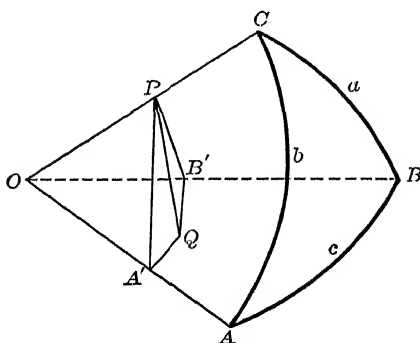


FIG. 58

the center  $O$  of the sphere draw radii to the vertices  $A$ ,  $B$ , and  $C$  of the triangle. From any point  $P$  on  $OC$  draw  $PQ$  perpendicular to plane  $OAB$ . Through  $PQ$  pass planes perpendicular to  $OA$  and  $OB$  respectively, meeting these lines in  $A'$  and  $B'$ .

It is evident that angle  $PA'Q = A$  and angle  $PB'Q = B$ .

In right triangle  $A'PQ$ ,  $\sin A' = \sin A = \frac{PQ}{PA'}$ ,

In right triangle  $B'PQ$ ,  $\sin B' = \sin B = \frac{PQ}{PB'}$ ,

In right triangle  $OPB'$ ,  $\sin a = \frac{PB'}{OP}$

In right triangle  $OPA'$ ,  $\sin b = \frac{PA'}{OP}$

It follows that  $\frac{\sin A}{\sin a} = \frac{PQ}{PA'} \cdot \frac{OP}{PB'}$  and  $\frac{\sin B}{\sin b} = \frac{PQ}{PB'} \cdot \frac{OP}{PA'}$

Hence  $\frac{\sin A}{\sin a} = \frac{\sin B}{\sin b}$

The remainder of the theorem follows from analogy.

**67. The Law of Cosines.** In any spherical triangle,

*The cosine of any side is equal to the product of the cosines of the other two sides plus the product of the sines of these two sides and the cosine of the included angle.*

That is,  $\cos c = \cos a \cos b + \sin a \sin b \cos C$

**PROOF.** In a spherical triangle  $ABC$  (Fig. 59), draw the radii to the vertices. Draw tangents to  $a$  and  $b$  at  $C$ , letting them meet  $OA$  and  $OB$  produced in  $P$  and  $Q$  respectively.

Apply the law of cosines for plane triangles (Section 41) to triangles  $OPQ$  and  $CPQ$ , respectively, and subtract:

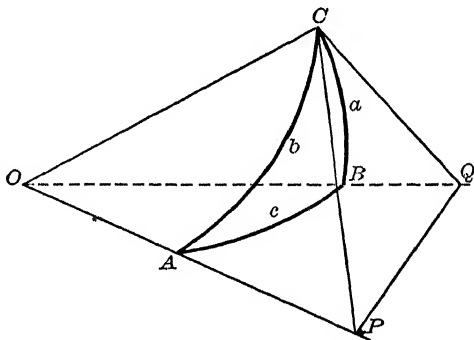


FIG. 59

$$\begin{aligned} (PQ)^2 &= (OQ)^2 + (OP)^2 - 2(OQ)(OP) \cos c \\ (PQ)^2 &= (CQ)^2 + (CP)^2 - 2(CQ)(CP) \cos C \\ 0 &= (OQ)^2 - (CQ)^2 + (OP)^2 - (CP)^2 \\ &\quad + 2(CQ)(CP) \cos C - 2(OQ)(OP) \cos c \end{aligned}$$

From the figure,  $(OQ)^2 - (CQ)^2 = (OC)^2$

and  $(OP)^2 - (CP)^2 = (OC)^2$

Hence  $0 = 2(OC)^2 + 2(CQ)(CP) \cos C - 2(OQ)(OP) \cos c$



Divide the last equation by 2 and transpose:

$$(OQ)(OP) \cos c = (OC)^2 + (CQ)(CP) \cos C$$

$$\cos c = \frac{OC}{OQ} \cdot \frac{OC}{OP} + \frac{CQ}{OQ} \cdot \frac{CP}{OP} \cos C$$

Replace the fractions by their values from Fig. 59:

$$\cos c = \cos a \cos b + \sin a \sin b \cos C$$

Starting with each of the three sides of the triangle, we have:

$$\left. \begin{aligned} \cos a &= \cos b \cos c + \sin b \sin c \cos A \\ \cos b &= \cos c \cos a + \sin c \sin a \cos B \\ \cos c &= \cos a \cos b + \sin a \sin b \cos C \end{aligned} \right\} \quad (93)$$

If  $ABC$  and  $A'B'C'$  are a pair of polar triangles, we have, from Theorem VII (Section 65):

$$A + a' = 180^\circ \qquad A' + a = 180^\circ, \text{ etc.}$$

Solve these relations from the primed letters:

$$\begin{aligned} a' &= 180^\circ - A & b' &= 180^\circ - B & c' &= 180^\circ - C \\ A' &= 180^\circ - a & B' &= 180^\circ - b & C' &= 180^\circ - c \end{aligned}$$

The law of cosines applied to triangle  $A'B'C'$  gives

$$\cos a' = \cos b' \cos c' + \sin b' \sin c' \cos A'$$

Make use of the above relations, recalling that  $\sin(180^\circ - \theta) = \sin \theta$  and  $\cos(180^\circ - \theta) = -\cos \theta$ :

$$\begin{aligned} \cos(180^\circ - A) &= \cos(180^\circ - B) \cos(180^\circ - C) \\ &\quad + \sin(180^\circ - B) \sin(180^\circ - C) \cos(180^\circ - a) \end{aligned}$$

$$\text{or} \quad -\cos A = \cos B \cos C - \sin B \sin C \cos a$$

Change signs:

$$\left. \begin{aligned} \cos A &= -\cos B \cos C + \sin B \sin C \cos a \\ \cos B &= -\cos C \cos A + \sin C \sin A \cos b \\ \cos C &= -\cos A \cos B + \sin A \sin B \cos c \end{aligned} \right\} \quad (94)$$

The last two equations are written from analogy.

## CHAPTER XIV

### SOLUTION OF THE RIGHT SPHERICAL TRIANGLE

**68. The Right-triangle Formulas.** A spherical triangle with one right angle is called a *right spherical triangle*.

Let  $C$  be the right angle. Then  $\sin C = 1$  and  $\cos C = 0$ .

Formulas 92, 93, and 94 become, respectively,

$$\begin{aligned}
 (a) \quad & \frac{\sin A}{\sin a} = \frac{\sin B}{\sin b} = \frac{1}{\sin c} \\
 & \cos a = \cos b \cos c + \sin b \sin c \cos A \\
 (b) \quad & \cos b = \cos c \cos a + \sin c \sin a \cos B \\
 & \cos c = \cos a \cos b \\
 (c) \quad & \begin{cases} \cos A = \sin B \cos a \\ \cos B = \sin A \cos b \end{cases} \\
 & 0 = -\cos A \cos B + \sin A \sin B \cos c
 \end{aligned}$$

From (a), we get

$$\begin{aligned}
 (1) \quad & \sin a = \sin A \sin c \\
 (2) \quad & \sin b = \sin B \sin c
 \end{aligned}$$

From the last equation of (b), we get

$$(3) \quad \cos c = \cos a \cos b$$

From the first and second equations of (c), we get

$$\begin{aligned}
 (4) \quad & \cos A = \sin B \cos a \\
 (5) \quad & \cos B = \sin A \cos b
 \end{aligned}$$

In each of the above five equations, substitute for each factor of the right-hand member its value as obtained from the only other equation in which the factor occurs. For instance, from (5),  $\sin A = \frac{\cos B}{\cos b}$  and from (2),  $\sin c = \frac{\sin b}{\sin B}$ . Substitute these values in the right-hand member of (1). Make similar substitutions in each of the other equations. The result is:

$$\begin{aligned}
 \sin a &= \sin A \sin c = \frac{\cos B}{\cos b} \cdot \frac{\sin b}{\sin B} = \frac{\cos B}{\sin B} \cdot \frac{\sin b}{\cos b} = \cot B \tan b \\
 \sin b &= \sin B \sin c = \frac{\cos A}{\cos a} \cdot \frac{\sin a}{\sin A} = \frac{\cos A}{\sin A} \cdot \frac{\sin a}{\cos a} = \cot A \tan a
 \end{aligned}$$

$$\begin{aligned}\cos c &= \cos a \cos b = \frac{\cos A}{\sin B} \cdot \frac{\cos B}{\sin A} = \frac{\cos A}{\sin A} \cdot \frac{\cos B}{\sin B} = \cot A \cot B \\ \cos A &= \sin B \cos a = \frac{\sin b}{\sin c} \cdot \frac{\cos c}{\cos b} = \frac{\sin b}{\cos b} \cdot \frac{\cos c}{\sin c} = \tan b \cot c \\ \cos B &= \sin A \cos b = \frac{\sin a}{\sin c} \cdot \frac{\cos c}{\cos a} = \frac{\sin a}{\cos a} \cdot \frac{\cos c}{\sin c} = \tan a \cot c\end{aligned}$$

Hence we have the following ten formulas, which are used in the solution of right spherical triangles:

- |                              |                               |
|------------------------------|-------------------------------|
| (1) $\sin a = \sin A \sin c$ | (6) $\sin a = \cot B \tan b$  |
| (2) $\sin b = \sin B \sin c$ | (7) $\sin b = \cot A \tan a$  |
| (3) $\cos c = \cos a \cos b$ | (8) $\cos c = \cot A \cot B$  |
| (4) $\cos A = \sin B \cos a$ | (9) $\cos A = \tan b \cot c$  |
| (5) $\cos B = \sin A \cos b$ | (10) $\cos B = \tan a \cot c$ |

Although the above formulas are important, they need not be memorized. Any or all of them may be written down as desired by means of the rules explained in the next section.

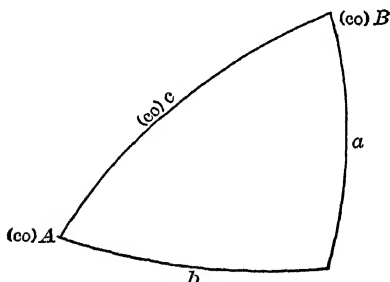


FIG. 60

69. **Napier's Rules.** Draw a right triangle (Fig. 60), omitting  $C$  from the lettering. The triangle now has five parts: three sides and two angles (omitting the right angle). The two parts on either side of a particular part are said to be *adjacent* to it; the other two are said to be *opposite*. For instance,  $A$  and  $a$  are adjacent to  $b$ , while

$c$  and  $B$  are opposite  $b$ . Write the symbol (co) before each letter along the hypotenuse; that is, before  $A$ ,  $c$ , and  $B$ .

Napier's Rules are:

I. *The sine of any part is equal to the product of the cosines of the opposite parts.*

II. *The sine of any part is equal to the product of the tangents of the adjacent parts.*

Whenever either of the above rules calls for a function of a part preceded by (co), write its co-function.

For example, applying Rule I to part  $A$  (Fig. 60), we get

$$\cos A = \sin B \cos a$$

## EXERCISE

By means of Napier's Rules, write down the ten formulas of Section 68.

Notice that Napier's Rules *do not prove* the formulas in question. They are merely an aid to memory.

**70. Theorems.** The following facts will be found useful:

I. *In a right spherical triangle, an angle and its opposite side are in the same quadrant.*

PROOF. From (6),  $\sin a = \cot B \tan b$

Since  $\sin a$  is essentially positive,  $\cot B$  and  $\tan b$  must be either both positive or both negative. Hence both  $B$  and  $b$  must be in the same (first or second) quadrant.

II. *If the two sides of a right spherical triangle are in the same quadrant, the hypotenuse is less than  $90^\circ$ ; but if they are in different quadrants, the hypotenuse is greater than  $90^\circ$ .*

PROOF. From (3),  $\cos c = \cos a \cos b$

If  $a$  and  $b$  are in the same quadrant,  $\cos c$  is positive and  $c$  is less than  $90^\circ$ ; but if  $a$  and  $b$  are in different quadrants,  $\cos c$  is negative and  $c$  is greater than  $90^\circ$ .

**71. The Solution of Right Spherical Triangles.** A right spherical triangle is determined by any two of its parts in addition to the right angle. In solving the triangle, mark the given parts in a drawing. Then select a part to be found and, by means of Napier's Rules, set up the formula connecting the two given parts and the part to be found. The actual computation may then be done by logarithms.

*Illustration 1.* Solve the right triangle:  $A = 31^\circ 46' 15''$ ,  $b = 105^\circ 17' 30''$ .

SOLUTION. To find  $c$ ,  $A$  is the middle part, with  $b$  and  $c$  adjacent.

Hence  $\cos A = \tan b \cot c$ , or  $\cot c = \cos A \cot b$

Formulas for  $B$  and  $a$  are obtained in a similar fashion.

For a partial check, use the formula connecting the three parts to be found.

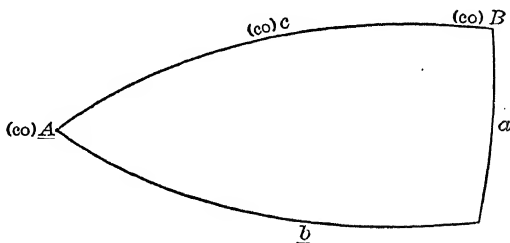


FIG. 61

The work should be arranged as follows:

$$\cot c = \cos A \cot b$$

$$\cos B = \sin A \cos b$$

$$\tan a = \sin b \tan A$$

CHECK.  $\cos B = \tan a \cot c$

$$A = 31^\circ 46' 15'' \log \cos = 9.92950 - 10 \dots \log \sin = 9.72142 - 10 \dots \log \tan = 9.79192 - 10$$

$$b = 105^\circ 17' 30'' \log \cot = 9.43682 - 10n \dots \log \cos = 9.42116 - 10n \dots \log \sin = 9.98435 - 10$$

$$c = 103^\circ 05' 08'' \log \cot = 9.36632 - 10n$$

$$B = 97^\circ 58' 55'' \dots \log \cos = \dots$$

$a :$

The necessary logarithms for the check appear in the above work. The check may be done mentally or the work may be appended to the right in another column.

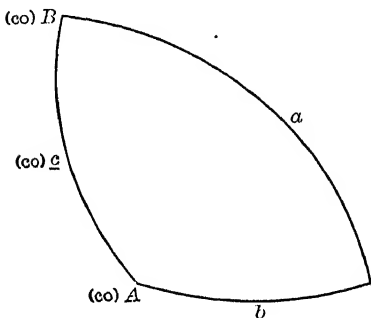


FIG. 62

*Illustration 2.* Solve the right triangle:

$$b = 48^\circ 32' 20''$$

$$c = 125^\circ 20' 12''$$

SOLUTION

$$\cos A = \tan b \cot c$$

$$\sin B = \frac{\sin b}{\sin c}$$

$$\cos a = \frac{\cos c}{\cos b}$$

CHECK

$$\cos A = \cos a \sin B$$

$$b = 48^\circ 32' 20'' \log \tan = 0.05379 \dots \log \sin = 9.87472 - 10 \dots \log \cos = 9.82093 - 10n$$

$$c = 125^\circ 20' 12'' \log \cot = 9.85064 - 10n \dots \log \sin = 9.91156 - 10 \dots \log \cos = 9.76222 - 10$$

$$A = 143^\circ 22' 00'' \log \cos = 9.90413 - 10n$$

$$B = 66^\circ 44' 00'' \dots \log \sin = 9.96316 - 10$$

$$a = 150^\circ 52' 26'' \dots \log \cos = 9.94129 - 10n$$

It should be noted that in right spherical triangles it is always possible to calculate each unknown part directly from the given parts.

In case the given parts are an angle and its opposite side, there are two solutions.

*Illustration 3.* Solve the right triangle:  $A = 62^\circ 37'$ ,  $a = 57^\circ 32'$ .

SOLUTION. Since the angles of a lune are equal, either triangle composing the lune (Fig. 63) contains the given parts.

$$\sin B = \cos A \sec a$$

$$\sin b = \tan a \cot A$$

$$\sin c = \sin a \csc A$$

CHECK

$$\sin b = \sin B \sin c$$

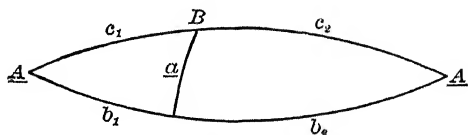


FIG. 63

|                                   |                                  |                             |                            |
|-----------------------------------|----------------------------------|-----------------------------|----------------------------|
| $\underline{A} = 62^\circ 37'$    | $\log \cos = 9.66270 - 10$       | $\log \cot = 9.71431 - 10$  | $\text{col sin} = 0.05161$ |
| $\underline{a} = 57^\circ 32'$    | $\text{col cos} = 0.27018 \dots$ | $\log \tan = 0.19637 \dots$ | $\log \sin = 9.92619 - 10$ |
| $\underline{B_1} = 58^\circ 58'$  | $\log \sin = 9.93288 - 10$       |                             |                            |
| $\underline{b_1} = 54^\circ 30'$  |                                  | $\log \sin = 9.91068 - 10$  |                            |
| $\underline{c_1} = 71^\circ 50'$  |                                  |                             | $\log \sin = 9.97780 - 10$ |
| $\underline{B_2} = 121^\circ 02'$ |                                  |                             |                            |
| $\underline{b_2} = 125^\circ 30'$ |                                  |                             |                            |
| $\underline{c_2} = 108^\circ 10'$ |                                  |                             |                            |

The theorems of Section 70 are used to determine which of the two values of  $b$  and  $c$  are to be associated with the first-quadrant value of  $B$ , and which with the second-quadrant value.

NOTE. When the given parts are in degrees and minutes only, it is assumed that the instrument used in measuring them gave results only to the nearest minute. In such a case, it is useless to interpolate for seconds in the answers.

## EXERCISES

Solve the following right spherical triangles:

- $a = 30^\circ$        $b = 60^\circ$       6.  $a = 113^\circ 43' 16''$      $c = 70^\circ 23' 57''$
- $a = 105^\circ 15'$      $A = 100^\circ 55'$     7.  $a = 20^\circ 38' 45''$      $B = 87^\circ 43' 15''$
- $b = 10^\circ 30' 18''$      $c = 13^\circ 14' 30''$     8.  $b = 26^\circ 52' 26''$      $A = 73^\circ 34' 23''$
- $b = 32^\circ 32' 32''$      $B = 55^\circ 50' 45''$     9.  $c = 90^\circ 45' 22''$      $A = 82^\circ 35' 24''$
- $c = 97^\circ 33' 56''$      $B = 96^\circ 01' 48''$     10.  $A = 35^\circ 43' 02''$      $B = 50^\circ 37' 10''$

**72. Isosceles Spherical Triangles.** If an isosceles spherical triangle is to be solved, divide it into two symmetrical right triangles by drawing the great circle arc through the vertex orthogonal to the base (Fig. 64). The partial solution of one of these right triangles gives the desired information.

## EXERCISES

Solve the following isosceles triangles:

- Base =  $22^\circ 18' 04''$   
Sides =  $18^\circ 23' 54''$
- Base =  $96^\circ 54' 44''$   
Base angles =  $60^\circ 05' 18''$
- Base =  $53^\circ 42' 45''$   
Angle at vertex =  $150^\circ 39' 42''$
- Sides =  $102^\circ 36' 59''$   
Base angles =  $74^\circ 54' 49''$
- Sides =  $40^\circ 40' 30''$   
Angle at vertex =  $81^\circ 21'$
- Base angles =  $75^\circ 52' 35''$   
Angle at vertex =  $62^\circ 35' 53''$

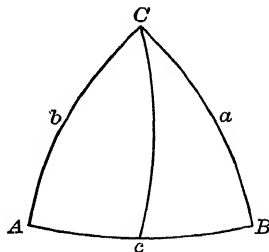


FIG. 64

**73. Quadrantal Triangles.** A spherical triangle with one side equal to  $90^\circ$  is called a *quadrantal triangle*. To solve such a triangle, merely solve its polar triangle. The unknown parts of the original triangle can then be obtained from the calculated parts of the right polar triangle by means of Theorem VII, Section 65.

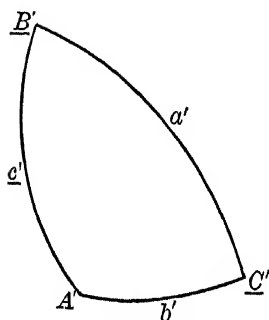


FIG. 65

*Illustration.* Solve the triangle:

$$c = 90^\circ, \quad b = 101^\circ 33' 30'', \quad C = 64^\circ 13' 45''.$$

SOLUTION

In the polar triangle,  $C' = 90^\circ$ ,  $B' = 78^\circ 26' 30''$ , and  $c' = 115^\circ 46' 15''$ .

$$\cot A' = \cos c' \tan B'$$

$$\sin b' = \sin c' \sin B'$$

$$\tan a' = \tan c' \cos B'$$

CHECK

$$\tan a' = \tan A' \sin b'$$

$$\begin{array}{llll} B' = 78^\circ 26' 30'' & \log \tan = 0.08928 \dots & \log \sin = 9.99111 - 10 & \log \cos = 9.30182 - 10 \\ c' = 115^\circ 46' 15'' & \log \cos = 9.63827 - 10n & \log \sin = 9.95450 - 10 & \log \tan = 0.31624n \\ A' = 154^\circ 48' 31'' & \log \cot = 0.32755n & & \\ a = 25^\circ 11' 23'' & & & \\ b' = 61^\circ 55' 09'' & \dots \dots \dots \log \sin = 9.94561 - 10 & & \\ B = 118^\circ 04' 51'' & & & \\ a' = 157^\circ 27' 40'' & \dots \dots \dots \log \tan = 9.61806 - 10n & & \\ A = 22^\circ 32' 20'' & & & \end{array}$$

#### EXERCISES

Solve the following triangles, in which  $c = 90^\circ$ :

- |                            |                          |
|----------------------------|--------------------------|
| 1. $A = 75^\circ 45' 42''$ | $B = 128^\circ 24' 01''$ |
| 2. $a = 96^\circ 48' 30''$ | $b = 47^\circ 53' 32''$  |
| 3. $A = 42^\circ 00' 16''$ | $C = 122^\circ 03' 25''$ |
| 4. $A = 25^\circ 50' 06''$ | $b = 100^\circ 42' 28''$ |

## CHAPTER XV

### SOLUTION OF THE OBLIQUE SPHERICAL TRIANGLE

**74. The Half-angle Formulas.** As in plane trigonometry, the law of cosines is not in a form convenient for logarithmic computation. Formulas will be developed analogous to the half-angle formulas of plane trigonometry.

From Formula 93:

$$(A) \quad \cos A = \frac{\cos a - \cos b \cos c}{\sin b \sin c}$$

Substitute (A) in Formula 34, page 53:

$$\begin{aligned} 2 \sin^2 \frac{1}{2}A &= 1 - \cos A = 1 - \frac{\cos a - \cos b \cos c}{\sin b \sin c} \\ &= \frac{\sin b \sin c - \cos a + \cos b \cos c}{\sin b \sin c} \\ &= \frac{\cos(b-c) - \cos a}{\sin b \sin c} \end{aligned}$$

Make use of (40), page 55:

$$\begin{aligned} 2 \sin^2 \frac{1}{2}A &= \frac{-2 \sin \frac{1}{2}(b-c+a) \sin \frac{1}{2}(b-c-a)}{\sin b \sin c} \\ &= \frac{2 \sin \frac{1}{2}(a+b-c) \sin \frac{1}{2}(a-b+c)}{\sin b \sin c} \end{aligned}$$

Let  $s = \frac{1}{2}(a+b+c)$ :

$$\left. \begin{aligned} \sin^2 \frac{1}{2}A &= \frac{\sin(s-b) \sin(s-c)}{\sin b \sin c} \\ \sin^2 \frac{1}{2}B &= \frac{\sin(s-c) \sin(s-a)}{\sin c \sin a} \\ \sin^2 \frac{1}{2}C &= \frac{\sin(s-a) \sin(s-b)}{\sin a \sin b} \end{aligned} \right\} \quad (95)$$

The last two equations are written from analogy.



Similarly, substitute (A) in Formula 35, page 53:

$$\begin{aligned} 2 \cos^2 \frac{1}{2}A &= 1 + \cos A = 1 + \frac{\cos a - \cos b \cos c}{\sin b \sin c} \\ &= \frac{\sin b \sin c + \cos a - \cos b \cos c}{\sin b \sin c} \\ &= \frac{\cos a - \cos(b+c)}{\sin b \sin c} \end{aligned}$$

Make use of (40), page 55:

$$\begin{aligned} 2 \cos^2 \frac{1}{2}A &= \frac{-2 \sin \frac{1}{2}(a+b+c) \sin \frac{1}{2}(a-b-c)}{\sin b \sin c} \\ &= \frac{2 \sin \frac{1}{2}(a+b+c) \sin \frac{1}{2}(b+c-a)}{\sin b \sin c} \end{aligned}$$

Hence

$$\begin{aligned} \cos^2 \frac{1}{2}A &= \frac{\sin s \sin(s-a)}{\sin b \sin c} \\ \cos^2 \frac{1}{2}B &= \frac{\sin s \sin(s-b)}{\sin c \sin a} \\ \cos^2 \frac{1}{2}C &= \frac{\sin s \sin(s-c)}{\sin a \sin b} \end{aligned} \quad (96)$$

Divide each equation in (95) by the appropriate one in (96):

$$\begin{aligned} \tan^2 \frac{1}{2}A &= \frac{\sin(s-b) \sin(s-c)}{\sin s \sin(s-a)} \\ \tan^2 \frac{1}{2}B &= \frac{\sin(s-c) \sin(s-a)}{\sin s \sin(s-b)} \\ \tan^2 \frac{1}{2}C &= \frac{\sin(s-a) \sin(s-b)}{\sin s \sin(s-c)} \end{aligned} \quad (97)$$

If  $r^*$  is defined so that

$$\tan^2 r = \frac{\sin(s-a) \sin(s-b) \sin(s-c)}{\sin s} \quad (98)$$

the formulas in (97) may be written thus:

$$\begin{aligned} \tan \frac{1}{2}A &= \frac{\tan r}{\sin(s-a)} \\ \tan \frac{1}{2}B &= \frac{\tan r}{\sin(s-b)} \\ \tan \frac{1}{2}C &= \frac{\tan r}{\sin(s-c)} \end{aligned} \quad (99)$$

$r^*$  is the radius of the inscribed circle, as in the case of plane trigonometry.

**75. The Half-side Formulas.** Solve the first equation of (94) for  $\cos a$ :

$$(B) \quad \cos a = \frac{\cos B \cos C + \cos A}{\sin B \sin C}$$

Substitute (B) in Formula 34, page 53:

$$\begin{aligned} 2 \sin^2 \frac{1}{2}a &= 1 - \frac{\cos B \cos C + \cos A}{\sin B \sin C} \\ &= \frac{\sin B \sin C - \cos B \cos C - \cos A}{\sin B \sin C} \\ &= -\frac{\cos(B+C) + \cos A}{\sin B \sin C} \\ &= -2 \cos \frac{1}{2}(A+B+C) \cos \frac{1}{2}(B+C-A) \\ &= \frac{\sin B \sin C}{\sin B \sin C} \end{aligned}$$

Let  $S = \frac{1}{2}(A+B+C)$ :

$$\sin^2 \frac{1}{2}a = \frac{-\cos S \cos(S-A)}{\sin B \sin C}$$

$$\begin{aligned} \text{Similarly,} \quad \sin^2 \frac{1}{2}b &= \frac{-\cos S \cos(S-B)}{\sin C \sin A} \\ \sin^2 \frac{1}{2}c &= \frac{-\cos S \cos(S-C)}{\sin A \sin B} \end{aligned} \tag{100}$$

Substitute (B) in Formula 35, page 53:

$$\begin{aligned} 2 \cos^2 \frac{1}{2}a &= 1 + \cos a = 1 + \frac{\cos B \cos C + \cos A}{\sin B \sin C} \\ &= \frac{\sin B \sin C + \cos B \cos C + \cos A}{\sin B \sin C} \\ &= \frac{\cos A + \cos(B-C)}{\sin B \sin C} \\ &= \frac{2 \cos \frac{1}{2}(A+B-C) \cos \frac{1}{2}(A-B+C)}{\sin B \sin C} \end{aligned}$$

$$\begin{aligned} \text{Hence} \quad \cos^2 \frac{1}{2}a &= \frac{\cos(S-B) \cos(S-C)}{\sin B \sin C} \\ \cos^2 \frac{1}{2}b &= \frac{\cos(S-C) \cos(S-A)}{\sin C \sin A} \\ \cos^2 \frac{1}{2}c &= \frac{\cos(S-A) \cos(S-B)}{\sin A \sin B} \end{aligned} \tag{101}$$

Divide each equation of Formula 100 by the corresponding one of Formula 101:

$$\begin{aligned}\tan^2 \frac{1}{2}a &= \frac{\cos S \cos (S-A)}{\cos (S-B) \cos (S-C)} \\ \tan^2 \frac{1}{2}b &= -\frac{\cos S \cos (S-B)}{\cos (S-C) \cos (S-A)} \\ &\quad \frac{\cos S \cos (S-C)}{\cos (S-A) \cos (S-B)}\end{aligned}\quad (102)$$

If we write:

$$\tan^2 R^* = \frac{-\cos S}{\cos (S-A) \cos (S-B) \cos (S-C)} \quad (103)$$

the equations in (102) become:

$$\left. \begin{aligned}\tan \frac{1}{2}a &= \tan R \cos (S-A) \\ \tan \frac{1}{2}b &= \tan R \cos (S-B) \\ \tan \frac{1}{2}c &= \tan R \cos (S-C)\end{aligned}\right\} \quad (104)$$

NOTE. From spherical geometry,

$$180^\circ < 2S < 540^\circ, \text{ or } 90^\circ < S < 270^\circ,$$

which means that  $S$  must lie in either the second or the third quadrant. Hence  $\cos S$  is always negative, and  $-\cos S$  is always positive. This fact accounts for the apparent inconsistency of Formulas 100, 102, and 103, in which a square is equal to an apparently negative expression.

#### EXERCISE

Derive Formulas 100, 101, 102, and 104 by applying Formulas 95, 96, 97, and 99 to triangle  $A'B'C'$ , the polar triangle of  $ABC$ , and then using the polar relations  $A' = 180^\circ - a$ , etc.

76. Napier's Analogies. From (99):

$$\frac{\tan \frac{1}{2}A}{\tan \frac{1}{2}B} = \frac{\sin (s-b)}{\sin (s-a)}$$

Apply composition and division:

$$(C) \quad \frac{\tan \frac{1}{2}A + \tan \frac{1}{2}B}{\tan \frac{1}{2}A - \tan \frac{1}{2}B} = \frac{\sin (s-b) + \sin (s-a)}{\sin (s-b) - \sin (s-a)}$$

Write the left-hand member in terms of sines and cosines:

$$\frac{\tan \frac{1}{2}A + \tan \frac{1}{2}B}{\tan \frac{1}{2}A - \tan \frac{1}{2}B} = \frac{\frac{\sin \frac{1}{2}A}{\cos \frac{1}{2}A} + \frac{\sin \frac{1}{2}B}{\cos \frac{1}{2}B}}{\frac{\sin \frac{1}{2}A}{\cos \frac{1}{2}A} - \frac{\sin \frac{1}{2}B}{\cos \frac{1}{2}B}} = \frac{\sin \frac{1}{2}A \cos \frac{1}{2}B + \cos \frac{1}{2}A \sin \frac{1}{2}B}{\sin \frac{1}{2}A \cos \frac{1}{2}B - \cos \frac{1}{2}A \sin \frac{1}{2}B}$$

\*It can be shown that  $R$  is the radius of the circumscribed circle.

Replace the left-hand member of (C) by this value and use Formulas 20, 21, 37, and 38 (pages 49 and 55):

$$\begin{aligned}\frac{\sin \frac{1}{2}(A+B)}{\sin \frac{1}{2}(A-B)} &= \frac{\sin \frac{1}{2}(2s-a-b) \cos \frac{1}{2}(a-b)}{\cos \frac{1}{2}(2s-a-b) \sin \frac{1}{2}(a-b)} \\ &= \tan \frac{1}{2}c \cot \frac{1}{2}(a-b)\end{aligned}$$

$$\text{Hence} \quad \tan \frac{1}{2}(a-b) = \frac{\sin \frac{1}{2}(A-B)}{\sin \frac{1}{2}(A+B)} \tan \frac{1}{2}c \quad (105)$$

Multiply the first and second equations of (97) and extract the square root:

$$\tan \frac{1}{2}A \tan \frac{1}{2}B = \frac{\sin(s-c)}{\sin s}$$

Write the left-hand member in terms of sines and cosines and invert:

$$\frac{\cos \frac{1}{2}A \cos \frac{1}{2}B}{\sin \frac{1}{2}A \sin \frac{1}{2}B} = \frac{\sin s}{\sin(s-c)}$$

Apply composition and division:

$$\frac{\cos \frac{1}{2}A \cos \frac{1}{2}B + \sin \frac{1}{2}A \sin \frac{1}{2}B}{\cos \frac{1}{2}A \cos \frac{1}{2}B - \sin \frac{1}{2}A \sin \frac{1}{2}B} = \frac{\sin s + \sin(s-c)}{\sin s - \sin(s-c)}$$

$$\text{Reduce:} \quad \frac{\cos \frac{1}{2}(A-B)}{\cos \frac{1}{2}(A+B)} = \frac{2 \sin \frac{1}{2}(2s-c) \cos \frac{1}{2}c}{2 \cos \frac{1}{2}(2s-c) \sin \frac{1}{2}c} = \frac{\tan \frac{1}{2}(a+b)}{\tan \frac{1}{2}c}$$

$$\text{Hence} \quad \tan \frac{1}{2}(a+b) = \frac{\cos \frac{1}{2}(A-B)}{\cos \frac{1}{2}(A+B)} \tan \frac{1}{2}c \quad (106)$$

Apply Formulas 105 and 106 to polar triangle  $A'B'C'$  and make use of the polar relations  $A' = 180^\circ - a$ ,  $a' = 180^\circ - A$ , etc.:

$$\tan \frac{1}{2}(A-B) = \frac{\sin \frac{1}{2}(a-b)}{\sin \frac{1}{2}(a+b)} \cot \frac{1}{2}C \quad (107)$$

$$\tan \frac{1}{2}(A+B) = \frac{\cos \frac{1}{2}(a-b)}{\cos \frac{1}{2}(a+b)} \cot \frac{1}{2}C \quad (108)$$

Formulas 105, 106, 107, and 108 are known as *Napier's Analogies*. They are used in solving oblique spherical triangles.

**77. The Solution of Oblique Spherical Triangles.** Formulas sufficient for the complete solution of any spherical triangle can be selected from the following:

$$s = \frac{1}{2}(a+b+c) \quad S = \frac{1}{2}(A+B+C) \quad (109)$$

$$\tan^2 r = \frac{\sin(s-a) \sin(s-b) \sin(s-c)}{\sin s} \quad (98)$$

$$\tan^2 R = \frac{-\cos S}{\cos (S-A) \cos (S-B) \cos (S-C)} \quad (103)$$

$$\tan \frac{1}{2} A = \frac{\tan r}{\sin (s-a)}, \text{ etc.} \quad (99)$$

$$\tan \frac{1}{2} a = \tan R \cos (S-A), \text{ etc.} \quad (104)$$

$$\tan \frac{1}{2} (a-b) = \frac{\sin \frac{1}{2} (A-B)}{\sin \frac{1}{2} (A+B)} \tan \frac{1}{2} c \quad (105)$$

$$\tan \frac{1}{2} (a+b) = \frac{\cos \frac{1}{2} (A-B)}{\cos \frac{1}{2} (A+B)} \tan \frac{1}{2} c \quad (106)$$

$$\tan \frac{1}{2} (A-B) = \frac{\sin \frac{1}{2} (a-b)}{\sin \frac{1}{2} (a+b)} \cot \frac{1}{2} C \quad (107)$$

$$\tan \frac{1}{2} (A+B) = \frac{\cos \frac{1}{2} (a-b)}{\cos \frac{1}{2} (a+b)} \cot \frac{1}{2} C \quad (108)$$

$$\frac{\sin A}{\sin a} = \frac{\sin B}{\sin b} = \frac{\sin C}{\sin c} \quad (92)$$

**THEOREM IX.** *The half sum of any two sides is in the same quadrant as the half sum of the opposite angles.*

**PROOF.** In a spherical triangle,  $\frac{1}{2}(A+B) < 180^\circ$ ,  $\frac{1}{2}(a+b) < 180^\circ$ ,  $\frac{1}{2}(A-B) < 90^\circ$ , and  $\frac{1}{2}c < 90^\circ$ . It follows that, in (106),  $\tan \frac{1}{2}c$  and  $\cos \frac{1}{2}(A-B)$  are both positive. Hence  $\tan \frac{1}{2}(a+b)$  and  $\cos \frac{1}{2}(A+B)$  are both of the same sign, therefore in the same quadrant.

**78. Case I. Given the Three Sides.** The necessary formulas are (98) and (99). See the illustrative example on page 105.

**79. Case II. Given the Three Angles.** The formulas are:

$$\tan^2 R = \frac{-\cos S}{\cos (S-A) \cos (S-B) \cos (S-C)}$$

$$\tan \frac{1}{2} a = \tan R \cos (S-A), \text{ etc.}$$

The work should be arranged as in Case I. The check formulas are the same.

#### EXERCISES

Solve the following triangles:

- |                            |                         |                         |
|----------------------------|-------------------------|-------------------------|
| 1. $a = 30^\circ$          | $b = 60^\circ$          | $c = 90^\circ$          |
| 2. $a = 73^\circ 47' 28''$ | $b = 58^\circ 52' 48''$ | $c = 89^\circ 45' 21''$ |

*Illustration.* Solve the triangle:  $a = 116^\circ 42' 16''$ ,  $b = 62^\circ 43' 18''$ ,  $c = 78^\circ 30' 30''$ .

*SOLUTION.*

$$\tan \frac{1}{2}A = \frac{\tan r}{\sin(s-a)}$$

$$\tan \frac{1}{2}B = \frac{\tan r}{\sin(s-b)}$$

$$\tan \frac{1}{2}C = \frac{\tan r}{\sin(s-c)}$$

*CHECK.* Law of sines:

$$\frac{\sin a}{\sin A} = \frac{\sin b}{\sin B} = \frac{\sin c}{\sin C}$$

$$a = 116^\circ 42' 16''$$

$$b = 62^\circ 43' 18''$$

$$c = 78^\circ 30' 30''$$

$$2s = 257^\circ 56' 04''$$

$$s = 128^\circ 58' 02''$$

$$s-a = 12^\circ 15' 46'' \dots \log \sin = 9.32714 - 10 \dots \text{col sin} = 0.67286$$

$$s-b = 66^\circ 14' 44'' \dots \log \sin = 9.96155 - 10 \dots \text{col sin} = 0.03845$$

$$s-c = 50^\circ 27' 32'' \dots \log \sin = 9.88715 - 10 \dots \text{col sin} = 0.11285$$

$$s = 128^\circ 58' 02'' \dots \text{col sin} = 0.10929$$

$$r = \dots \log \tan^2 = 19.28513 - 20$$

$$r = \dots \log \tan = 9.64257 - 10 \dots \log \tan = 9.64257 - 10 \dots \log \tan = 9.64257 - 10$$

$$A = 128^\circ 22' 30'' \dots \frac{1}{2}A = 64^\circ 11' 15'' \dots \log \tan = 0.31543$$

$$B = 51^\circ 15' 34'' \dots \frac{1}{2}B = 25^\circ 37' 47'' \dots \log \tan = 9.68102 - 10$$

$$C = 59^\circ 18' 54'' \dots \frac{1}{2}C = 29^\circ 39' 27'' \dots \log \tan = 9.75542 - 10$$

$$\begin{array}{r} \text{CHECK.} \quad \log \sin a = 9.95101 - 10 \\ \log \sin A = 9.89430 - 10 \\ \hline 0.05671 \end{array}$$

$$\begin{array}{r} \log \sin b = 9.94880 - 10 \\ \log \sin B = 9.89209 - 10 \\ \hline 0.05671 \end{array}$$

$$\begin{array}{r} \log \sin c = 9.99120 - 10 \\ \log \sin C = 9.93449 - 10 \\ \hline 0.05671 \end{array}$$

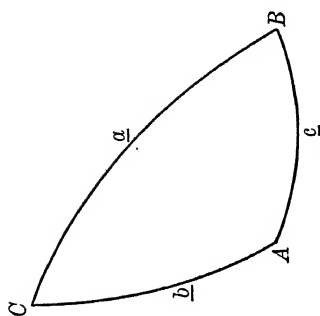


Fig. 66

Solve the following triangles:

- |                             |                          |                          |
|-----------------------------|--------------------------|--------------------------|
| 3. $a = 127^\circ 36' 40''$ | $b = 34^\circ 42' 08''$  | $c = 132^\circ 26' 00''$ |
| 4. $a = 52^\circ 23' 20''$  | $b = 145^\circ 17' 52''$ | $c = 47^\circ 34' 00''$  |
| 5. $A = 60^\circ$           | $B = 120^\circ$          | $C = 150^\circ$          |
| 6. $A = 128^\circ 54'$      | $B = 76^\circ 25'$       | $C = 102^\circ 01'$      |
| 7. $A = 127^\circ 36' 40''$ | $B = 34^\circ 42' 08''$  | $C = 132^\circ 26' 00''$ |
| 8. $A = 91^\circ 26' 47''$  | $B = 92^\circ 49' 05''$  | $C = 93^\circ 58' 21''$  |

### 80. Case III. Given Two Sides and the Included Angle.

The other two angles are found from Formulas 107 and 108, and the third side from Formula 105. The law of sines may be used as a check.

*Illustration.* Solve the triangle:  
 $a = 119^\circ 53'$ ,  $b = 74^\circ 43'$ ,  $C = 55^\circ 08'$ .

SOLUTION

$$\tan \frac{1}{2}(A+B) = \frac{\cos \frac{1}{2}(a-b)}{\cos \frac{1}{2}(a+b)} \cot \frac{1}{2}C$$

$$\tan \frac{1}{2}(A-B) = \frac{\sin \frac{1}{2}(a-b)}{\sin \frac{1}{2}(a+b)} \cot \frac{1}{2}C$$

$$\tan \frac{1}{2}c = \frac{\sin \frac{1}{2}(A+B)}{\sin \frac{1}{2}(A-B)} \tan \frac{1}{2}(a-b)$$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\frac{a}{\sin A} = \frac{b}{\sin B}$$

$$\frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\frac{c}{\sin C} = \frac{a}{\sin A}$$

$$\frac{1}{2}(a+b) = 97^\circ 18' \quad \log \cos = 9.96535 - 10 \quad \log \sin = 9.58436 - 10 \quad \log \tan = 9.61901 - 10$$

$$\frac{1}{2}(a-b) = 22^\circ 35' \quad \log \cos = 9.96535 - 10 \quad \log \sin = 9.58436 - 10 \quad \log \tan = 9.61901 - 10$$

$$\frac{1}{2}C = 27^\circ 34' \quad \log \cot = 0.28229 \dots \log \cot = 0.28229$$

$$\frac{1}{2}(A+B) = 94^\circ 07' \quad \log \tan = 1.14362n \dots \log \sin = 9.99888 - 10$$

$$\frac{1}{2}(A-B) = 36^\circ 34' \dots \log \tan = 9.87018 - 10 \quad \log \sin = 0.22498$$

$$\frac{1}{2}c = 34^\circ 51' \dots \log \tan = 9.84287 - 10$$

$$A = 130^\circ 41'$$

$$B = 57^\circ 33'$$

$$c = 69^\circ 42'$$

Check with the law of sines.

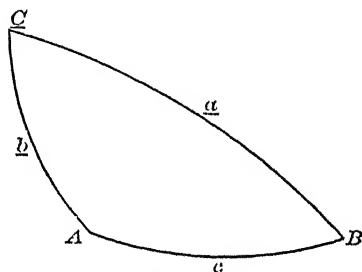


FIG. 67

### 81. Case IV. Given Two Angles and the Included Side.

If the given parts are  $A$ ,  $B$ , and  $c$ , the formulas are:

$$\tan \frac{1}{2}(a+b) = \frac{\cos \frac{1}{2}(A-B)}{\cos \frac{1}{2}(A+B)} \tan \frac{1}{2}c$$

$$\tan \frac{1}{2}(a-b) = \frac{\sin \frac{1}{2}(A-B)}{\sin \frac{1}{2}(A+B)} \tan \frac{1}{2}c$$

$$\cot \frac{1}{2}C = \frac{\sin \frac{1}{2}(a+b)}{\sin \frac{1}{2}(a-b)} \tan \frac{1}{2}(A-B)$$

As usual, the law of sines serves as a check.

The logarithmic work should be arranged as in Case III.

## EXERCISES

Solve the triangles:

- |                           |                       |                        |
|---------------------------|-----------------------|------------------------|
| 1. $a=100^\circ$          | $b=75^\circ$          | $C=135^\circ$          |
| 2. $a=72^\circ 26'$       | $b=109^\circ 24'$     | $C=90^\circ 16'$       |
| 3. $b=99^\circ 28' 11''$  | $c=63^\circ 45' 19''$ | $A=93^\circ 37' 41''$  |
| 4. $a=50^\circ 50' 02''$  | $c=71^\circ 34' 18''$ | $B=115^\circ 56' 07''$ |
| 5. $A=60^\circ$           | $B=120^\circ$         | $c=150^\circ$          |
| 6. $B=44^\circ 52' 06''$  | $C=57^\circ 24' 18''$ | $a=129^\circ 27' 11''$ |
| 7. $A=58^\circ 24' 30''$  | $B=48^\circ 45' 15''$ | $c=93^\circ 23' 24''$  |
| 8. $A=123^\circ 32' 22''$ | $C=40^\circ 36' 36''$ | $b=60^\circ 00' 30''$  |

**82. Case V. Given Two Sides and an Angle Opposite One of Them.** If the given parts are  $a$ ,  $b$ , and  $A$ , the formulas are:

$$\sin B = \frac{\sin b \sin A}{\sin a}$$

$$\tan \frac{1}{2}c = \frac{\cos \frac{1}{2}(A+B)}{\cos \frac{1}{2}(A-B)} \tan \frac{1}{2}(a+b)$$

$$\cot \frac{1}{2}C = \frac{\cos \frac{1}{2}(a+b)}{\cos \frac{1}{2}(a-b)} \tan \frac{1}{2}(A+B)$$

Since  $B$  is obtained from the sine, there may be two solutions. It is also possible to have but one solution or no solution. See page 108 for illustrative example.

**83. Case VI. Given Two Angles and the Side Opposite One of Them.** If the given parts are  $A$ ,  $B$ , and  $a$ , the formulas are:

$$\sin b = \frac{\sin B \sin a}{\sin A}$$

$$\tan \frac{1}{2}c = \frac{\cos \frac{1}{2}(A+B)}{\cos \frac{1}{2}(A-B)} \tan \frac{1}{2}(a+b)$$

$$\cot \frac{1}{2}C = \frac{\cos \frac{1}{2}(a+b)}{\cos \frac{1}{2}(a-b)} \tan \frac{1}{2}(A+B)$$

$$\text{CHECK.} \quad \cot \frac{1}{2}C = \frac{\sin \frac{1}{2}(a+b)}{\sin \frac{1}{2}(a-b)} \tan \frac{1}{2}(A-B)$$

The work should be arranged as in Case V. Since  $b$  is obtained from its sine, there may be two solutions. Theorem IX, Section 77, must be used to determine whether there are two solutions, one solution, or no solution.



*Illustration.* Solve the triangle:  $a = 142^\circ 26'$ ,  $b = 60^\circ 20'$ ,  $A = 153^\circ 55'$ .

*SOLUTION.*

$$\sin B = \frac{\sin b \sin A}{\sin a}$$

$$\cot \frac{1}{2}C = \frac{\cos \frac{1}{2}(a+b)}{\cos \frac{1}{2}(a-b)} \tan \frac{1}{2}(A+B)$$

$$\tan \frac{1}{2}c = \frac{\cos \frac{1}{2}(A+B)}{\cos \frac{1}{2}(A-B)} \tan \frac{1}{2}(a+b)$$

$$\cot \frac{1}{2}C = \frac{\sin \frac{1}{2}(a+b)}{\sin \frac{1}{2}(a-b)} \tan \frac{1}{2}(A-B)$$

CHECK.

$$\cot \sin = 0.21490$$

$$\log \sin = 9.93898 - 10$$

$$\log \sin = 9.64313 - 10$$

$$\log \sin = 9.79701 - 10$$

$$a = 142^\circ 26'$$

$$b = 60^\circ 20'$$

$$A = 153^\circ 55'$$

$$B_1 = 38^\circ 48'$$

$$B_2 = 141^\circ 12'$$

$$\frac{1}{2}(a+b) = 101^\circ 23'$$

$$\frac{1}{2}(a-b) = 41^\circ 03'$$

$$\frac{1}{2}(A+B_1) = 96^\circ 22'$$

$$\frac{1}{2}(A-B_1) = 57^\circ 33'$$

$$\frac{1}{2}(A+B_2) = 147^\circ 33'$$

$$\frac{1}{2}(A-B_2) = 6^\circ 22'$$

$$\frac{1}{2}c_1 = 45^\circ 43'$$

$$\frac{1}{2}C_1 = 23^\circ 04'$$

$$\frac{1}{2}c_2 = 76^\circ 40'$$

$$\frac{1}{2}C_2 = 80^\circ 33'$$

$$c_1 = 91^\circ 27'$$

$$C_1 = 46^\circ 08'$$

$$c_2 = 153^\circ 19'$$

$$C_2 = 161^\circ 06'$$

|                             |                             |                        |                             |                            |
|-----------------------------|-----------------------------|------------------------|-----------------------------|----------------------------|
| $\log \tan = 0.69609n$      | $\log \cos = 9.29529 - 10n$ | $\log \tan = 0.69609n$ | $\log \cos = 9.29529 - 10n$ | $\log \sin = 9.99137 - 10$ |
| .....                       | col. cos = 0.12255          | .....                  | col. cos = 0.12255          | col. sin = 0.18262         |
| $\log \cos = 9.04441 - 10n$ | $\log \tan = 0.95292n$      | .....                  | $\log \cos = 9.29529 - 10n$ | $\log \tan = 0.19677$      |
| col. cos = 0.27047          | .....                       | .....                  | $\log \tan = 9.80323 - 10n$ | .....                      |
| .....                       | $\log \tan = 0.01097$       | .....                  | col. cos = 0.00268          | .....                      |
| .....                       | .....                       | .....                  | $\log \cos = 9.29529 - 10n$ | $\log \tan = 0.37076$      |
| .....                       | $\log \cot = 0.37076$       | .....                  | col. cos = 0.62507          | .....                      |
| .....                       | .....                       | .....                  | $\log \tan = 0.62507$       | $\log \cot = 0.37076$      |
| .....                       | .....                       | .....                  | .....                       | $\log \cot = 9.22107 - 10$ |

CHECK FOR SECOND SOLUTION.  $\log \sin \frac{1}{2}(a+b) = 9.99137 - 10$

$$\cot \sin \frac{1}{2}(a-b) = 0.18262$$

$$\log \tan \frac{1}{2}(A-B_1) = 9.04705 - 10$$

$$\log \cot \frac{1}{2}C_2 = 9.22107 - 10$$

When a part is calculated from the sine formula, as in the case of  $B$  above, it is necessary to use Theorem IX, Section 77, in order to determine the number of possible solutions. Although the answers are given to the nearest minute only, it is necessary to consider the seconds when looking up logarithms of computed parts.

## EXERCISES

Solve the following triangles:

1.  $a = 102^\circ 25'$        $b = 71^\circ 40'$        $A = 78^\circ 55'$
2.  $b = 74^\circ 49' 06''$        $c = 81^\circ 38' 18''$        $C = 85^\circ 39' 51''$
3.  $a = 75^\circ 27' 42''$        $c = 99^\circ 54' 54''$        $A = 60^\circ 01' 30''$
4.  $A = 121^\circ 58'$        $B = 52^\circ 28'$        $a = 140^\circ 50'$
5.  $A = 131^\circ 00' 12''$        $B = 140^\circ 53' 18''$        $b = 130^\circ 43' 24''$
6.  $B = 74^\circ 19' 42''$        $C = 87^\circ 48' 48''$        $c = 92^\circ 38' 06''$

## GENERAL EXERCISES

Solve the following triangles:

1.  $A = 32^\circ 40' 56''$        $B = 146^\circ 18' 05''$        $c = 56^\circ 15' 30''$
2.  $a = 28^\circ 17' 40''$        $b = 58^\circ 27' 45''$        $c = 26^\circ 52' 30''$
3.  $A = 98^\circ 42' 39''$        $b = 78^\circ 16' 48''$        $c = 45^\circ 55' 18''$
4.  $B = 104^\circ 18' 30''$        $C = 128^\circ 42' 15''$        $b = 99^\circ 20' 00''$
5.  $A = 92^\circ 12' 18''$        $B = 48^\circ 16' 32''$        $C = 108^\circ 19' 24''$
6.  $a = 15^\circ 20' 06''$        $b = 10^\circ 23' 54''$        $c = 12^\circ 53' 12''$
7.  $A = 15^\circ 20' 06''$        $B = 10^\circ 23' 54''$        $C = 12^\circ 53' 12''$
8.  $A = 108^\circ 26' 10''$        $C = 110^\circ 58' 24''$        $b = 28^\circ 16' 42''$
9.  $a = 108^\circ 26' 10''$        $c = 110^\circ 58' 24''$        $B = 28^\circ 16' 42''$
10.  $b = 142^\circ 50' 16''$        $c = 62^\circ 48' 17''$        $B = 151^\circ 48' 15''$

## CHAPTER XVI

### APPLICATIONS OF SPHERICAL TRIGONOMETRY

**84. The Earth as a Sphere.** Our ordinary unit of measurement of distance is the *statute mile*, equivalent to 5280 ft. The *geographical mile*, also called the *nautical mile*, is the length of one minute of arc of a great circle of the earth. It is equivalent to about 6080 ft. A *knot* is a speed of one nautical mile per hour.

For many practical purposes the earth may be considered as a sphere with a radius of about 3960 statute miles.

If  $A$  and  $B$  are two points on the surface of the earth, the *bearing* of  $B$  from  $A$  is the acute angle between the meridian through  $A$  and the great circle arc  $AB$ . The bearing of New York from San Francisco is  $N\ 69^{\circ}\ 55'\ E$  (read "north  $69^{\circ}\ 55'$  east"). That is, any one standing in San Francisco facing north and then turning  $69^{\circ}\ 55'$  to the east would face New York.

The position of a point on the earth is uniquely determined by its latitude and longitude. A symbol ( $35^{\circ}\ N$ ,  $96^{\circ}\ W$ ) following the name of a point on the earth is read " $35^{\circ}$  north latitude,  $96^{\circ}$  west longitude" (west of Greenwich). See the illustrative example on page 111.

#### EXERCISES

1. Find the airline distance and the bearing of Fairbanks, Alaska ( $64^{\circ}\ 51'\ N$ ,  $147^{\circ}\ 44'\ W$ ) from Chicago ( $41^{\circ}\ 50'\ N$ ,  $87^{\circ}\ 37'\ W$ ).
2. Find the halfway point on the great-circle route from London ( $51^{\circ}\ 30'\ N$ ,  $0^{\circ}$ ) to Yokohama ( $35^{\circ}\ 27'\ N$ ,  $139^{\circ}\ 39'\ E$ ).
3. Find the distance and the bearing of Rio de Janeiro ( $22^{\circ}\ 54'\ S$ ,  $43^{\circ}\ 10'\ W$ ) from New Orleans ( $29^{\circ}\ 57'\ N$ ,  $90^{\circ}\ 04'\ W$ ).
4. Find the distance and the farthest north point on the route from New York ( $40^{\circ}\ 43'\ N$ ,  $74^{\circ}\ W$ ) to Yokohama ( $35^{\circ}\ 27'\ N$ ,  $139^{\circ}\ 39'\ E$ ).
5. Find the distance and the bearing of Manila ( $14^{\circ}\ 35'\ N$ ,  $120^{\circ}\ 59'\ E$ ) from Honolulu ( $21^{\circ}\ 18'\ N$ ,  $157^{\circ}\ 52'\ W$ ).

**85. The Celestial Sphere.** The stars and other celestial objects appear to be on the surface of a sphere of which the observer is the center. While this is not actually the case, we can make it so by imagining ourselves the center of such a sphere

*Illustration.* Find the distance between New York ( $40^{\circ} 43' \text{ N}$ ,  $74^{\circ} \text{ W}$ ) and San Francisco ( $37^{\circ} 48' \text{ N}$ ,  $122^{\circ} 28' \text{ W}$ ). Find the bearing of each from the other. Find the farthest north point on the great circle path between them.

$$\text{SOLUTION. } \tan \frac{1}{2}(B+A) = \frac{\cos \frac{1}{2}(b-a)}{\cos \frac{1}{2}(b+a)} \cot \frac{1}{2}C \quad \tan \frac{1}{2}(B-A) = \frac{\sin \frac{1}{2}(b-a)}{\sin \frac{1}{2}(b+a)} \cot \frac{1}{2}C$$

$$\tan \frac{1}{2}c = \frac{\cos \frac{1}{2}(B+A)}{\cos \frac{1}{2}(B-A)} \tan \frac{1}{2}(b+a)$$

$$\text{CHECK. } \tan \frac{1}{2}c = \frac{\sin \frac{1}{2}(B+A)}{\sin \frac{1}{2}(B-A)} \tan \frac{1}{2}(b-a)$$

$$C = 48^{\circ} 28'$$

$$\frac{1}{2}C = 24^{\circ} 14' \dots \dots \log \cot = 0.34667 \dots \dots \log \cot = 0.34667$$

$$b = 52^{\circ} 12'$$

$$\bar{b} = 49^{\circ} 17'$$

$$\frac{1}{2}(b-a) = 1^{\circ} 27' 30'' \dots \dots \log \cos = 9.99986 - 10 \dots \dots \log \sin = 8.40569 - 10 \dots \dots \log \tan = 8.40583 - 10$$

$$\frac{1}{2}(b+a) = 50^{\circ} 44' 30'' \dots \dots \log \cos = 0.19872 \dots \dots \log \sin = 0.11109 \dots \dots \log \tan = 0.08763$$

$$\frac{1}{2}(B+A) = 74^{\circ} 05' 45'' \dots \dots \log \tan = 0.54525 \dots \dots \log \cos = 9.43780 - 10 \dots \dots \log \sin = 9.98305 - 10$$

$$\frac{1}{2}(B-A) = 4^{\circ} 10' 35'' \dots \dots \log \tan = 8.86345 - 10 \dots \dots \log \cos = 0.00116 \dots \dots \log \sin = 1.13771$$

$$\frac{1}{2}c = 18^{\circ} 34' 57'' \dots \dots \log \tan = 9.52659 - 10 \dots \dots \log \tan = 9.52659 - 10$$

$$c = 37^{\circ} 09' 54''$$

$$B = 78^{\circ} 16' 20''$$

$$A = 69^{\circ} 55' 10'' \dots \dots \log \sin = 9.97277 - 10 \dots \dots \log \tan = 0.43704$$

$$b = 52^{\circ} 12' \dots \dots \log \sin = 9.89771 - 10 \dots \dots \log \cos = 9.78739 - 10$$

$$h = 47^{\circ} 54' 49'' \dots \dots \log \sin = 9.87048 - 10$$

$$\cot ACD = \cos b \tan A$$

$$ACD = 30^{\circ} 48' 50'' \dots \dots \log \cot = 0.22443$$

$$\sin h = \sin A \sin b$$

Hence the bearing of San Francisco from New York is  $N 78^{\circ} 16' \text{ W}$ ; the bearing of New York from San Francisco is  $N 69^{\circ} 55' \text{ E}$ ; the distance between them is 2230 geographical miles, or 2568 statute miles; and the farthest north point on the path is  $42^{\circ} 05' \text{ N}$ ,  $91^{\circ} 39' \text{ W}$ .

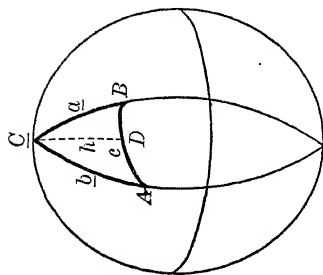


FIG. 68

of indefinite radius and representing each celestial object by the point in which the line joining it with the center of the sphere meets the surface of the sphere. We thus have the *celestial sphere*, which of course moves with the observer as he moves over the surface of the earth.

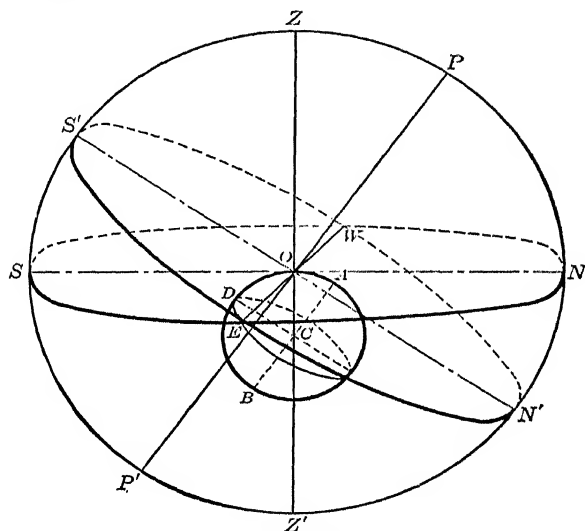


FIG. 69

In Fig. 69, let  $A$ ,  $B$ , and  $O$  be the north pole, the south pole, and the observer, respectively, all being on the surface of the earth. The plane tangent to the earth at  $O$  cuts the celestial sphere in a great circle  $SENW$ , called the *horizon*. The line through  $O$  parallel to the axis  $AB$  of the earth cuts the celestial sphere in  $P$  and  $P'$ , called respectively the *celestial north pole* and the *celestial south pole*. The plane through  $O$  parallel to the plane of the equator of the earth cuts the celestial sphere in great circle  $S'EN'W$ , called the *celestial equator*. It is clear that the latitude  $OD$  of  $O$  is measured by an angle  $OCD$ , which is equal to angle  $ZOS'$ . Hence  $S'Z = PN$  is the *latitude of the observer*.

Let us refer now to Fig. 70, page 113, which is the same as Fig. 69 with the earth omitted. Let  $M$  be any celestial object. Draw great circle arcs  $ZM$  and  $PM$  meeting the horizon and the celestial equator in  $K$  and  $L$  respectively.

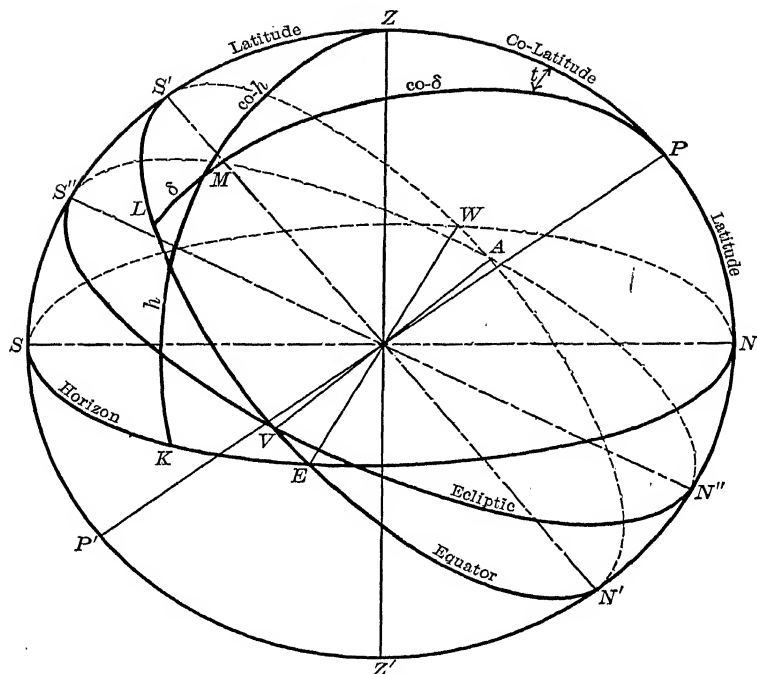


FIG. 70

$SZNZ'$  = Prime Meridian

$Z$  = Zenith,  $Z'$  = Nadir

$SENW$  = Horizon

$N$  = North Point,  $E$  = East Point

$S$  = South Point,  $W$  = West Point

$P$  = Celestial North Pole

$P'$  = Celestial South Pole

$S'EN'W$  = Celestial Equator

$PN = S'Z = L$  = Latitude of the Observer

$S''VN''A$  = Ecliptic

$A$  = Autumnal Equinoctial Point

$V$  = Vernal Equinoctial Point

$M$  = Celestial Object

$KM = h$  = Altitude of  $M$

$MZ = co-h$  = Co-altitude = Zenith Distance of  $M$

$LM = \delta^*$  = Declination of  $M$

$MP = co-\delta$  = Co-declination of  $M$

$t$  = Hour Angle of  $M$

$NK$  = Angle  $NZK$  = Azimuth of  $M$

$MZP$  = Astronomical Triangle

$EZW$  = Prime Vertical

$VL$  = Right Ascension of  $M$

The path which the earth follows in its yearly journey around the sun is called the *ecliptic*. The plane of the ecliptic makes an angle of about  $23^\circ 27'$  with the plane of the equator.

\*The Greek letter "delta."

Notice that the sides of the important astronomical triangle (see Fig. 70) are co-latitude, co-altitude, and co-declination. The two named angles are the hour angle and the azimuth. If any three of these five parts are known, the other two can be calculated by solving the astronomical triangle.

apparent time. See Appendix, page 119.

115.

NOTE. The declination of the sun for each day can be found in the *American Ephemeris and Nautical Almanac*, published yearly by the United States Naval Observatory. This volume contains a great amount of material valuable to navigators. It should be noticed that the declination of the sun varies from  $-23^{\circ} 27'$  at the time of the winter solstice (our shortest day) to  $23^{\circ} 27'$  at the time of the summer solstice (our longest day.)

## EXERCISES

1. When the sun's declination is  $15^{\circ}$ , where and when will it rise at a place in latitude  $45^{\circ}$ ?
2. What is the declination of the sun when it rises at 5 A.M. at Chicago ( $41^{\circ} 50' N$ )?
3. At New York ( $40^{\circ} 43' N$ ) the sun is observed to rise  $32^{\circ} 48' N$  of E. What is its declination?
4. What is the declination of a star that sets exactly in the southwest in latitude  $45^{\circ} 24'$ ?
5. Find the time of sunrise at the Cornell University Observatory ( $42^{\circ} 26' 47'' N$ ) when the declination of the sun is (a)  $18^{\circ} 20' 06''$ ; (b)  $-23^{\circ} 27'$ .
6. When the declination of a star is  $-11^{\circ} 58' 12''$ , its altitude is observed to be  $60^{\circ} 01' 18''$  and its azimuth,  $142^{\circ} 22' 24'' W$  of N. What is the latitude of the observer?
7. In what latitude will the sun rise exactly in the southeast at the time of the winter solstice?
8. In what latitude will the length of the shortest day be 4 hr.?
9. What will be the altitude of the sun at Morgantown ( $39^{\circ} 38' 12'' N$ ) at 2 P.M. at the time of (a) the summer solstice? (b) the winter solstice?
10. As observed from latitude  $30^{\circ} 27' 15''$ , the altitude of a star is  $23^{\circ} 18' 30''$  and its declination is  $15^{\circ} 18' 24''$ . Find its azimuth and hour angle.
11. At Buenos Aires ( $34^{\circ} 36' S$ ) the altitude of a star is  $41^{\circ} 20'$  and its azimuth is  $87^{\circ} 32' W$  of N. What is its declination?
12. At what time is the sun exactly east at Columbia University ( $40^{\circ} 48' 35'' N$ ) at the time of the summer solstice? What is its altitude?
13. What is the declination of the sun when its center is on the horizon at noon at Point Barrow ( $71^{\circ} 23' 30'' N$ )? What is its position?
14. Find  $t$  when  $L=17^{\circ} 06' N$ ,  $\delta=20^{\circ} 01'$ ,  $h=30^{\circ} 17'$ .
15. Find  $h$  when  $t=30^{\circ} 15' 30''$ ,  $L=68^{\circ} 18' 20'' N$ , azimuth =  $126^{\circ} 18' 42'' E$  of N.
16. Find time of sunset when  $L=0^{\circ} 18' 36'' N$ ,  $\delta=-15^{\circ} 10' 18''$ .
17. Find  $t$  and azimuth when  $L=23^{\circ} 17' 18'' S$ ,  $h=30^{\circ} 1' 30''$ ,  $\delta=16^{\circ} 18' 20''$ .



## APPENDIX

**86. The Solar System.** The *solar system* is composed of the *sun*, nine major *planets*, and their *moons* or *satellites*, some hundreds—or perhaps thousands—of *asteroids* or *planetoids*, and a number of *comets*. Each of the planets, accompanied by its satellites, rotates around the sun in a definite period.

The planets, in order from the sun out, are: *Mercury* (0), *Venus* (0), *Earth* (1), *Mars* (2), *Jupiter* (9), *Saturn* (10), *Uranus* (4), *Neptune* (1), and the recently discovered *Pluto*. The figures in parentheses represent the number of satellites each planet is known to have. Between Mars and Jupiter are the *planetoids*, a large number of little planets.

**87. Kepler's Laws of Planetary Motion.** The following three laws can be proved mathematically, but not without the use of differential equations:

I. *Each planet moves around the sun in an ellipse, the sun being at one focus.*

II. *The radius vector\* of each planet describes equal areas in equal intervals of time.*

III. *The squares of the periods of the planets are proportional to the cubes of the semimajor axes of their orbits.*

### EXERCISES

1. The period of the earth is one year—about 365 days—and that of Mercury, about 88 days. Find the distance of Mercury from the sun, the distance of the earth from the sun being about 92,000,000 miles. (Their orbits are so nearly circular that the distance can be used for the semimajor axis.)

2. If the distance from the earth to the sun were increased by 10%, how would the year be affected?

3. How long does it take light from the sun, traveling at the rate of 186,300 mi. per second, to reach the earth?

**88. The Earth as a Planet.** The earth is a *spheroid* with an equatorial radius of 6,378,206 meters and a polar radius of 6,356,584 meters. The centrifugal force due to the rotation of the earth on its axis causes the so-called "equatorial ring" of

\*The line joining the planet with the sun.

matter around the center of the earth. If the earth did not rotate, it would probably be spherical in shape.

The orbits of all the planets are nearly circular. The eccentricity of the earth's orbit is about  $\frac{1}{60}$ .

The period of the earth is one year, or approximately  $365\frac{1}{4}$  days.

*The plane of the ecliptic* (plane of the earth's orbit) makes an angle of about  $23^{\circ} 27'$  with the plane of the equator. This fact causes the seasons.

The earth is in *perihelion* (nearest the sun) Dec. 31 and in *aphelion* (farthest from the sun) a half year later.

**89. Precession of the Equinoxes.** The axis of the earth is not quite fixed in direction, but rotates slowly, causing the poles (and hence celestial poles) to move. This precession causes the vernal and autumnal equinoctial points to move around the ecliptic at such speed as to make a complete circle in about 26,000 years. This motion is caused by the couple exerted by the sun and the moon on the earth's equatorial ring of matter.

**90. The Moon.** The moon is about  $\frac{1}{80}$  the mass of the earth. It rotates on its axis each time it rotates around the earth, which is about once a month. Hence we see but one side of the moon.

The moon produces no light of its own. Moonlight is merely reflected sunlight.

Only half of the moon is illuminated at any one time. When the half which is turned toward us is illuminated, we have *full moon*. When the half which is turned away from us is illuminated, we have *new moon*. When half of the portion toward us is illuminated, we have *first quarter* or *last quarter*, depending on whether the visible illuminated portion is increasing or decreasing. These various stages of illumination are called the *phases of the moon*.

Often when only a portion of the side of the moon toward us is illuminated, the non-illuminated part is distinctly visible. The faint illumination thus noticed is caused by sunlight reflected from the earth, or "earthshine." It must be remembered that the earth, as seen from the moon, passes through all the phases of illumination that the moon, as observed from the earth, does. "Earthshine," as observed from the moon, is

probably 15 to 20 times brighter than moonshine, as seen from the earth. This is due to the larger size of the earth and its greater reflecting power.

**91. The Stars.** The sun is a star. The other components of the solar system are not. Light from the sun requires about 8 minutes to reach the earth. (See page 116, ex. 3.) Light from our next nearest star ( $\alpha$  Centauri) requires about  $4\frac{1}{2}$  years to reach us. That is,  $\alpha$  Centauri is  $4\frac{1}{2}$  light years away. Astronomers now study stars which are millions of light years away.

It is evident from the above that the stars, even though they are moving rapidly, remain approximately in the same apparent relative positions in the sky. Hence astronomers refer to the *fixed stars*.

#### EXERCISE

How many miles away is  $\alpha$  Centauri?

**92. Eclipses.** An eclipse of the sun occurs when the moon passes between the observer and the sun, thus shutting off the sun's light. A total eclipse of the sun is visible over only a small

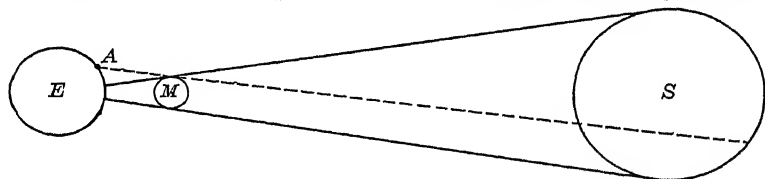


FIG. 72

part of the earth's surface (Fig. 72), but appears as a partial eclipse over a wide area. For example, as observed from point A (Fig. 72), the portion of the sun below the dotted line is eclipsed.

An eclipse of the moon occurs when the earth passes between the sun and the moon. A total eclipse of the moon is visible over approximately half the surface of the earth (Fig. 73).

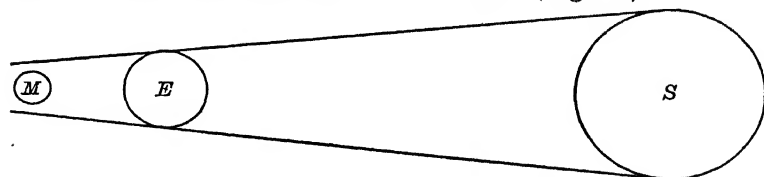


FIG. 73

## EXERCISES

1. Why must an eclipse of the sun occur at new moon and an eclipse of the moon, at full moon?

2. There are more total eclipses of the sun than of the moon, yet the average person sees more of the latter than of the former. Why?

**93. Time.** *Sidereal time* is measured by the hour angle of the vernal equinox. It may be measured by the hour angle of a fixed star to within one day in 26,000 years. The discrepancy is due to the precession of the equinoxes.

*Apparent solar time* is measured by the hour angle of the sun. Because the sun's apparent motion is not uniform, apparent solar days are not all of equal length. December 23 is 51 seconds longer than September 16.

*Mean solar time* is measured by the hour angle of a fictitious sun which is assumed to move uniformly around the celestial equator. Mean solar days are all the same length.

*Standard time* is the mean solar time along a particular meridian. For instance, Eastern Standard Time is the mean solar time along the 75th meridian.

The *equation of time* is the difference between mean solar time and apparent solar time. It must be added (algebraically) to apparent solar time to get mean solar time. It may be either positive or negative, and may be as much as 16 minutes. The equation of time for each day is given in the *Ephemeris*.

## EXERCISES

1. Explain the fact that a sidereal year contains  $366\frac{1}{4}$  days, while a solar year contains but  $365\frac{1}{4}$  days.

2. Find the Eastern Standard Time of sunrise at Morgantown in the illustrative example in Section 85, page 114, if the equation of time for that day is +13 min. 56 sec. The longitude of Morgantown is  $79^{\circ} 59' 30''$ .

**94. The Noon Observation.** When the sun is on the prime meridian (local apparent noon), the latitude of the observer is equal to the zenith distance of the sun plus its declination.

That is (Fig. 74):  $L = S'Z = z + \delta$

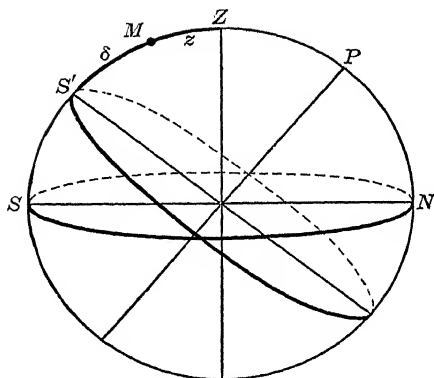


FIG. 74

The altitude of the sun is taken with an instrument called a *sextant*. When it is nearly noon, the observer watches the sun through the sextant until it reaches its maximum altitude (local apparent noon). This maximum altitude, as read from the sextant, is then subtracted from  $90^\circ$ , giving the zenith distance of the sun at noon.

The longitude of the observer can be determined by observing the time of local apparent noon on a timepiece which keeps Greenwich time. For instance, if the sun is observed to cross the meridian at 3 p.m., Greenwich time, the longitude is  $45^\circ$  W. The equation of time must be taken into consideration if an accurate determination is to be made.

The noon observation is much used by navigators to determine their position at sea. Each ship carries an accurate time piece called a *chronometer*, which is set with Greenwich time.

**95. Observation of a Circumpolar Star.** The altitude of the celestial north pole is the latitude of the observer (Fig. 70, page 113). There is no star exactly at the celestial north pole; but the north star, Polaris, is not far from there (a little over a degree away).

The altitude of the north star at lower (or upper) culmination,\* plus (or minus) the radius of the circle apparently described by the north star, is the latitude of the observer. This gives the navigator a chance to determine his latitude on a clear night. The altitude of the north star at eastern (or western) elongation\*\* is approximately the latitude of the observer. Why is it not exactly so?

\*When lowest (or highest) in the sky.

\*\*When farthest east (or farthest west).

**96. Captain Sumner's Method.** At any instant the sun is directly over some spot of the earth, called the *sub-solar point*. The sun's declination, as taken from the *Ephemeris*, is the latitude of this point. Its longitude can be determined from the chronometer reading. This sub-solar point is then located on the navigator's chart, and the altitude of the sun is taken. The co-altitude, or zenith distance, of the sun is the distance of the observer from the sub-solar point. Hence *the observer is on a circle with sub-solar point as center and zenith distance as radius*. A little later, another observation is made and another circle determined. The observer is at one of the intersections of these two circles.\* The position of the observer is then located directly on the chart. There is seldom any doubt at which point of intersection of the two circles the observer is located. If there should be, the direction of the sun will determine the correct point. One of the two points is northeast of the sun, the other is southeast of it.

In practice, since a navigator knows approximately where he is, only small arcs of the circles are used, and these are approximated by straight lines.

**97. Refraction.** In order to obtain accurate results from astronomical observations, several corrections must be made on the observed data. The equation of time (Section 93) must be used when time is to be considered.

Light travels more slowly through air than through empty space, just as it travels more slowly through water than through air. This fact causes light rays to bend when passing through the atmosphere, just as they bend when entering water, and makes an object appear to be slightly higher in the sky than it actually is. This apparent displacement is called *refraction*. It is zero for an object at the zenith and a maximum for an object on the horizon, where it may be as much as 40'. Because of refraction, we can actually see an object which is just below the physical horizon. There is no definite boundary between the earth's atmosphere and empty space, such as exists between air and water. Hence refraction is not a sudden change of direction, but a gradual change which progresses as the density of the atmosphere increases.

\*If on a moving ship, account must be taken of the distance traveled between observations.

**98. Parallax.** *Diurnal parallax* is the difference between the direction of a celestial object as actually observed and the direction it would have if observed from the center of the earth.

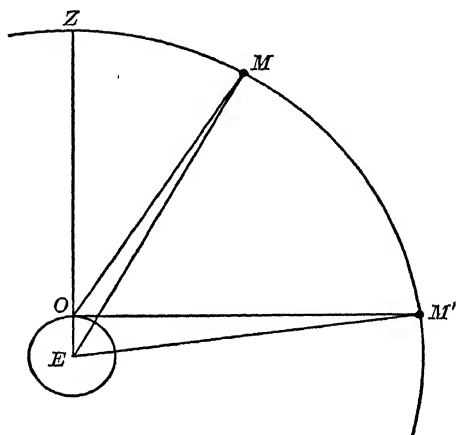


FIG. 75

In Fig. 75, the diurnal parallax of object  $M$  as observed from  $O$  is the angle  $OME$ . The parallax of an object at the zenith is zero. It is a maximum when the object is on the horizon and is then called the *horizontal parallax*. The horizontal parallax of  $M'$  is angle  $OM'E$ .

The horizontal parallax of the sun is about  $8.8''$ .

Because of their great distance, the stars have no observable diurnal parallax. But the closer stars have a measurable *annual parallax*, defined as the difference between the direction of an object as observed from the earth and the direction it would have if observed from the center of the earth's orbit. The annual parallax can be used to calculate the distances of the stars for which it can be measured.

**99. Aberration.** The apparent displacement of an object due to the combination of the motion of the light from it with the motion of the observer is called *aberration*. To an observer in a moving car, falling raindrops appear to come from a different direction than is actually the case. The difference between the apparent direction and the actual direction is exactly analogous to aberration. The velocity of the observer is the velocity of the earth as it revolves in its orbit. Because the velocity of light is so much greater than the velocity of the observer, the aberration is always small, reaching a maximum of about  $20.5''$  when the direction of the object is perpendicular to the orbit of the earth.

*Diurnal aberration* is caused by the velocity of the observer due to the rotation of the earth on its axis. Its maximum value is about  $0.3''$ .

The results in extremely careful astronomical observations must be corrected for refraction, parallax, and aberration. Refraction is the only one of the three which needs to be considered in ordinary observations, such as those which are made by navigators.

100. **Tides.** The *tides* are caused by the gravitational force of the moon and, to a lesser extent, of the sun. The water on the side of the earth next to the moon, being closer to the moon than the earth proper, is acted upon more strongly by the gravitational force of the moon, and is drawn away from the earth, causing a tide. In a similar manner, the earth is drawn away from the water on the opposite side of the earth. Hence there are two *lunar tides* daily, about 12 hours apart. There are two much smaller and scarcely noticeable *solar tides* daily. The highest tides, called *spring tides*, occur at new and full moon when the lunar and solar tides coincide. The smallest tides, or *neap tides*, occur at quarter moon, when the gravitational forces of the sun and the moon acting on the earth are at right angles to each other.

The tide is not highest when the moon is on the prime meridian, as it apparently should be. As the earth rotates, the tide lags behind, high tide occurring some hours after the moon has passed the meridian.



# RECAPITULATION OF FORMULAS

## FORMULAS FOR PLANE TRIGONOMETRY

### Angle Measurement

$$\theta = \frac{s}{r} \quad (1)$$

$$180^\circ = \pi \text{ radians} \quad (2)$$

$$\frac{x^\circ}{180^\circ} = \frac{\theta}{\pi} \quad (3)$$

### Eight Fundamental Identities

$$\cot A = \frac{1}{\tan A} \quad (4)$$

$$\sec A = \frac{1}{\cos A} \quad (5)$$

$$\csc A = \frac{1}{\sin A} \quad (6)$$

$$\tan A = \frac{\sin A}{\cos A} \quad (7)$$

$$\cot A = \frac{\cos A}{\sin A} \quad (8)$$

$$\sin^2 A + \cos^2 A = 1 \quad (9)$$

$$\tan^2 A + 1 = \sec^2 A \quad (10)$$

$$\cot^2 A + 1 = \csc^2 A \quad (11)$$

### Some Important Limits

$$\lim_{\theta \rightarrow 0} \frac{\theta}{\sin \theta} = 1 \quad (12)$$

$$\lim_{\theta \rightarrow 0} \frac{\theta}{\tan \theta} = 1 \quad (13)$$

### Small Angles

$$\log \sin \theta = \log \theta + S \quad (14)$$

$$\log \tan \theta = \log \theta + T \quad (15)$$

### Functions of Any Angle

$$\text{Any function of } \left. \begin{matrix} 180^\circ \pm \theta \\ 360^\circ \pm \theta \end{matrix} \right\} = \pm \text{ same function of } \theta \quad (16)$$

$$\text{Any function of } \left. \begin{matrix} 90^\circ + \theta \\ 270^\circ \pm \theta \end{matrix} \right\} \pm \text{ co-function of } \theta \quad (17)$$

### Definitions

$$\text{vers } \theta = 1 - \cos \theta \quad (18)$$

$$\text{covers } \theta = 1 - \sin \theta \quad (19)$$

### Functions of Two Angles

$$\sin (x+y) = \sin x \cos y + \cos x \sin y \quad (20)$$

$$\cos (x+y) = \cos x \cos y - \sin x \sin y \quad (21)$$

$$\tan (x+y) = \frac{\tan x + \tan y}{1 - \tan x \tan y} \quad (22)$$

$$\cot (x+y) = \frac{\cot x \cot y - 1}{\cot x + \cot y} \quad (23)$$

$$\sin (x-y) = \sin x \cos y - \cos x \sin y \quad (24)$$

$$\cos (x-y) = \cos x \cos y + \sin x \sin y \quad (25)$$

$$\tan (x-y) = \frac{\tan x - \tan y}{1 + \tan x \tan y} \quad (26)$$

$$\cot (x-y) = \frac{\cot x \cot y + 1}{\cot y - \cot x} \quad (27)$$

### Functions of Twice an Angle

$$\sin 2x = 2 \sin x \cos x \quad (28)$$

$$\cos 2x = \cos^2 x - \sin^2 x \quad (29)$$

$$\tan 2x = \frac{2 \tan x}{1 - \tan^2 x} \quad (30)$$

**Functions of Three Times an Angle**

$$\sin 3x = 3 \sin x - 4 \sin^3 x \quad (31)$$

$$\cos 3x = 4 \cos^3 x - 3 \cos x \quad (32)$$

$$\tan 3x = \frac{3 \tan x - \tan^3 x}{1 - 3 \tan^2 x} \quad (33)$$

**Functions of Half an Angle**

$$\sin \frac{x}{2} = \pm \sqrt{\frac{1 - \cos x}{2}} \quad (34)$$

$$\cos \frac{x}{2} = \pm \sqrt{\frac{1 + \cos x}{2}} \quad (35)$$

$$\tan \frac{x}{2} = \frac{\sin \frac{x}{2}}{\cos \frac{x}{2}} = \pm \sqrt{\frac{1 - \cos x}{1 + \cos x}} \quad (36)$$

**Sums and Differences of Functions**

$$\sin A + \sin B = 2 \sin \frac{1}{2}(A+B) \cos \frac{1}{2}(A-B) \quad (37)$$

$$\sin A - \sin B = 2 \cos \frac{1}{2}(A+B) \sin \frac{1}{2}(A-B) \quad (38)$$

$$\cos A + \cos B = 2 \cos \frac{1}{2}(A+B) \cos \frac{1}{2}(A-B) \quad (39)$$

$$\cos A - \cos B = -2 \sin \frac{1}{2}(A+B) \sin \frac{1}{2}(A-B) \quad (40)$$

**Laws of Sines, Cosines, and Tangents**

$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c} \quad (41)$$

$$a^2 = b^2 + c^2 - 2bc \cos A \quad (42)$$

$$\frac{a+b}{a-b} = \frac{\tan \frac{1}{2}(A+B)}{\tan \frac{1}{2}(A-B)} \quad (43)$$

$$\frac{b+c}{b-c} = \frac{\tan \frac{1}{2}(B+C)}{\tan \frac{1}{2}(B-C)} \quad (44)$$

$$\frac{c+a}{c-a} = \frac{\tan \frac{1}{2}(C+A)}{\tan \frac{1}{2}(C-A)} \quad (45)$$

# Half-angle Formulas

$$a + b + c = 2s \quad (46)$$

$$\sin \frac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{bc}} \quad (47)$$

$$\sin \frac{1}{2} B = \sqrt{\frac{(s-c)(s-a)}{ca}} \quad (48)$$

$$\sin \frac{1}{2} C = \sqrt{\frac{(s-a)(s-b)}{ab}} \quad (49)$$

$$\text{hav } A = \frac{(s-b)(s-c)}{bc} \quad (50)$$

$$\text{hav } B = \frac{(s-c)(s-a)}{ca} \quad (51)$$

$$\text{hav } C = \frac{(s-a)(s-b)}{ab} \quad (52)$$

$$\cos \frac{1}{2} A = \sqrt{\frac{s(s-a)}{bc}} \quad (53)$$

$$\cos \frac{1}{2} B = \quad (54)$$

$$\cos \frac{1}{2} C = \quad (55)$$

$$\tan \frac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}} \quad (56)$$

$$\tan \frac{1}{2} B = \sqrt{\frac{(s-c)(s-a)}{s(s-b)}} \quad (57)$$

$$\tan \frac{1}{2} C = \sqrt{\frac{(s-a)(s-b)}{s(s-c)}} \quad (58)$$

$$= \sqrt{\frac{(s-a)(s-b)(s-c)}{s^3}} \quad (59)$$

$$\tan \frac{1}{2} A = \frac{s-a}{s} \quad (60)$$

$$\tan \frac{1}{2} B = \frac{t}{s-b} \quad (61)$$

$$\tan \frac{1}{2} C = \frac{r}{s-c} \quad (62)$$

### Area of Right Triangle

$$C = 180^\circ \quad (63)$$

$$K = \frac{1}{2} ab \quad (64)$$

$$K = \frac{1}{2} bc \sin A = \frac{1}{2} ac \sin B \quad (65)$$

$$K = \frac{1}{2} b^2 \tan A = \frac{1}{2} a^2 \tan B \quad (66)$$

$$K = \frac{1}{2} a \sqrt{(c+a)(c-a)} \quad (67)$$

$$K = \frac{1}{2} c^2 \sin A \cos A = \frac{1}{4} c^2 \sin 2A \quad (68)$$

### Area of Oblique Triangle

$$K = \frac{1}{2} hc \quad (69)$$

$$K = \frac{1}{2} bc \sin A \quad (70)$$

$$K = \frac{c^2 \sin A \sin B}{2 \sin C} \quad (71)$$

$$K = \sqrt{s(s-a)(s-b)(s-c)} \quad (72)$$

### Inscribed and Circumscribed Circles

$$r = \sqrt{\frac{(s-a)(s-b)(s-c)}{s}} \quad (73)$$

$$\sin A = \frac{\frac{1}{2} a}{R} = \frac{a}{2R} \quad (74)$$

$$R = \frac{a}{2 \sin A} = \frac{b}{2 \sin B} = \frac{c}{2 \sin C} \quad (75)$$

$$R = \frac{abc}{4K} = \frac{abc}{2ah} = \frac{abc}{2b\sin A} = \frac{abc}{2c\sin B} \quad (76)$$

### Medians of a Triangle

$$m_1 = \sqrt{\frac{1}{2}(b^2 + c^2) - \frac{1}{4}a^2} \quad (77)$$

### Area of Segment of a Circle

$$K = \frac{1}{2} r^2 (\theta - \sin \theta) \quad (78)$$

### Complex Numbers

$$x + iy = r (\cos \theta + i \sin \theta) \quad (79)$$

$$\begin{aligned} (x_1 + iy_1) (x_2 + iy_2) \dots (x_n + iy_n) \\ = r_1 r_2 \dots r_n [\cos (\theta_1 + \theta_2 + \dots + \theta_n) + i \sin (\theta_1 + \theta_2 + \dots + \theta_n)] \end{aligned} \quad (80)$$

### De Moivre's Theorem

$$(\cos \theta + i \sin \theta)^n = \cos n\theta + i \sin n\theta \quad (81)$$

### Roots of Complex Numbers

$$(\cos \theta + i \sin \theta)^{\frac{1}{n}} = \cos \frac{\theta}{n} + i \sin \frac{\theta}{n} \quad (82)$$

$$\sqrt[n]{x + iy} = \sqrt[n]{r} \left[ \cos \frac{\theta + 360^\circ k}{n} + i \sin \frac{\theta + 360^\circ k}{n} \right] \quad (83)$$

### Power Series

$$\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \frac{x^8}{8!} - \dots \quad (84)$$

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \frac{x^9}{9!} - \dots \quad (85)$$

$$\lim_{n \rightarrow \infty} \left( 1 + \frac{1}{n} \right)^n \quad (86)$$

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \frac{x^5}{5!} + \dots \quad (87)$$

$$e = 1 + 1 + \frac{1}{2!} + \frac{1}{3!} + \frac{1}{4!} + \frac{1}{5!} + \dots = 2.71828 \dots \quad (88)$$

**Exponential Formulas**

$$\begin{aligned} e^{i\theta} &= \cos \theta + i \sin \theta \\ e^{-i\theta} &= \cos \theta - i \sin \theta \end{aligned} \quad (89)$$

$$\begin{aligned} \cos \theta &= \frac{e^{i\theta} + e^{-i\theta}}{2} \\ \sin \theta &= \frac{e^{i\theta} - e^{-i\theta}}{2i} \end{aligned} \quad (90)$$

**Hyperbolic Functions**

$$\begin{aligned} \sinh x &= \frac{e^x - e^{-x}}{2} \\ \cosh x &= \frac{e^x + e^{-x}}{2} \end{aligned} \quad (91)$$

**FORMULAS FOR SPHERICAL TRIGONOMETRY****Laws of Sines and Cosines**

$$\frac{\sin A}{\sin a} = \frac{\sin B}{\sin b} = \frac{\sin C}{\sin c} \quad (92)$$

$$\begin{aligned} \cos a &= \cos b \cos c + \sin b \sin c \cos A \\ \cos b &= \cos c \cos a + \sin c \sin a \cos B \\ \cos c &= \cos a \cos b + \sin a \sin b \cos C \end{aligned} \quad (93)$$

$$\begin{aligned} \cos A &= -\cos B \cos C + \sin B \sin C \cos a \\ \cos B &= -\cos C \cos A + \sin C \sin A \cos b \\ \cos C &= -\cos A \cos B + \sin A \sin B \cos c \end{aligned} \quad (94)$$

**Half-angle Formulas**

$$\left. \begin{aligned} \sin^2 \frac{1}{2}A &= \frac{\sin(s-b) \sin(s-c)}{\sin b \sin c} \\ \sin^2 \frac{1}{2}B &= \frac{\sin(s-c) \sin(s-a)}{\sin c \sin a} \\ \sin^2 \frac{1}{2}C &= \frac{\sin(s-a) \sin(s-b)}{\sin a \sin b} \end{aligned} \right\} \quad (95)$$

$$\begin{aligned}\cos^2 \frac{1}{2} A &= \frac{\sin s \sin (s-a)}{\sin b \sin c} \\ \cos^2 \frac{1}{2} B &= \frac{\sin s \sin (s-b)}{\sin c \sin a} \\ \cos^2 \frac{1}{2} C &= \frac{\sin s \sin (s-c)}{\sin a \sin b}\end{aligned}\quad (96)$$

$$\begin{aligned}\tan^2 \frac{1}{2} A &= \frac{\sin (s-b) \sin (s-c)}{\sin s \sin (s-a)} \\ \tan^2 \frac{1}{2} B &= \frac{\sin (s-c) \sin (s-a)}{\sin s \sin (s-b)} \\ \tan^2 \frac{1}{2} C &= \frac{\sin (s-a) \sin (s-b)}{\sin s \sin (s-c)}\end{aligned}\quad (97)$$

$$\tan^2 r = \frac{\sin (s-a) \sin (s-b) \sin (s-c)}{\sin s} \quad (98)$$

$$\begin{aligned}\tan \frac{1}{2} A &= \frac{\tan r}{\sin (s-a)} \\ \tan \frac{1}{2} B &= \frac{\tan r}{\sin (s-b)} \\ \tan \frac{1}{2} C &= \frac{\tan r}{\sin (s-c)}\end{aligned}\quad (99)$$

### Half-side Formulas

$$\begin{aligned}\sin^2 \frac{1}{2} a &= \frac{-\cos S \cos (S-A)}{\sin B \sin C} \\ \sin^2 \frac{1}{2} b &= \frac{-\cos S \cos (S-B)}{\sin C \sin A} \\ \sin^2 \frac{1}{2} c &= \frac{-\cos S \cos (S-C)}{\sin A \sin B}\end{aligned}\quad (100)$$

$$\begin{aligned}\cos^2 \frac{1}{2} a &= \frac{\cos (S-B) \cos (S-C)}{\sin B \sin C} \\ \cos^2 \frac{1}{2} b &= \frac{\cos (S-C) \cos (S-A)}{\sin C \sin A} \\ \cos^2 \frac{1}{2} c &= \frac{\cos (S-A) \cos (S-B)}{\sin A \sin B}\end{aligned}\quad (101)$$



$$\begin{aligned}
\tan^2 \frac{1}{2} a &= \frac{\cos S \cos (S-A)}{\cos (S-B) \cos (S-C)} \\
\tan^2 \frac{1}{2} b &= \frac{\cos S \cos (S-B)}{\cos (S-C) \cos (S-A)} \\
\tan^2 \frac{1}{2} c &= \frac{\cos S \cos (S-C)}{\cos (S-A) \cos (S-B)} \\
\tan^2 R &= \frac{-\cos S}{\cos (S-A) \cos (S-B) \cos (S-C)} \\
\tan \frac{1}{2} a &= \tan R \cos (S-A) \\
\tan \frac{1}{2} b &= \tan R \cos (S-B) \\
\tan \frac{1}{2} c &= \tan R \cos (S-C)
\end{aligned} \tag{102}$$

### Napier's Analogies

$$\tan \frac{1}{2}(a-b) = \frac{\sin \frac{1}{2}(A-B)}{\sin \frac{1}{2}(A+B)} \tan \frac{1}{2} c \tag{105}$$

$$\tan \frac{1}{2}(a+b) = \frac{\cos \frac{1}{2}(A-B)}{\cos \frac{1}{2}(A+B)} \tan \frac{1}{2} c \tag{106}$$

$$\tan \frac{1}{2}(A-B) = \frac{\sin \frac{1}{2}(a-b)}{\sin \frac{1}{2}(a+b)} \cot \frac{1}{2} C \tag{107}$$

$$\tan \frac{1}{2}(A+B) = \frac{\cos \frac{1}{2}(a-b)}{\cos \frac{1}{2}(a+b)} \cot \frac{1}{2} C \tag{108}$$

### Oblique Spherical Triangles

$$\left. \begin{aligned} s &= \frac{1}{2}(a+b+c) \\ S &= \frac{1}{2}(A+B+C) \end{aligned} \right\} \tag{109}$$

See also (92), (98), (99), and (103)-(108).

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# LOGARITHMIC AND TRIGONOMETRIC TABLES

*FIVE DECIMAL PLACES*

EDITED BY

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NOTE.—The well-known tables of Gauss, Becker, and Albrecht have been taken as the standards, the proof sheets have been read with great care, and it is believed that the number of errors cannot be large. The arrangement of the figures on the page is in accordance with that adopted in the standard six and seven place tables.

The natural tables were reduced from seven-place tables and compared with published five-place tables.

For convenience in using the tables, the explanation has been placed after them instead of before them.

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# I.

## COMMON

### LOGARITHMS OF NUMBERS

FROM 1 TO 11000.

| N.        | Log.     | N.        | Log.     | N.        | Log.     | N.        | Log.     | N.         | Log.     |
|-----------|----------|-----------|----------|-----------|----------|-----------|----------|------------|----------|
| <b>0</b>  | —        | <b>20</b> | 1.30 103 | <b>40</b> | 1.60 206 | <b>60</b> | 1.77 815 | <b>80</b>  | 1.90 309 |
| 1         | 0.00 000 | 21        | 1.32 222 | 41        | 1.61 278 | 61        | 1.78 533 | 81         | 1.90 849 |
| 2         | 0.30 103 | 22        | 1.34 242 | 42        | 1.62 323 | 62        | 1.79 239 | 82         | 1.91 381 |
| 3         | 0.47 712 | 23        | 1.36 173 | 43        | 1.63 347 | 63        | 1.79 934 | 83         | 1.91 908 |
| 4         | 0.60 206 | 24        | 1.38 021 | 44        | 1.64 345 | 64        | 1.80 618 | 84         | 1.92 428 |
| 5         | 0.69 897 | 25        | 1.39 794 | 45        | 1.65 321 | 65        | 1.81 291 | 85         | 1.92 942 |
| 6         | 0.77 815 | 26        | 1.41 497 | 46        | 1.66 276 | 66        | 1.81 954 | 86         | 1.93 450 |
| 7         | 0.84 510 | 27        | 1.43 136 | 47        | 1.67 210 | 67        | 1.82 607 | 87         | 1.93 952 |
| 8         | 0.90 309 | 28        | 1.44 716 | 48        | 1.68 124 | 68        | 1.83 251 | 88         | 1.94 448 |
| 9         | 0.95 424 | 29        | 1.46 240 | 49        | 1.69 020 | 69        | 1.83 885 | 89         | 1.94 939 |
| <b>10</b> | 1.00 000 | <b>30</b> | 1.47 712 | <b>50</b> | 1.69 897 | <b>70</b> | 1.84 510 | <b>90</b>  | 1.95 424 |
| 11        | 1.04 139 | 31        | 1.49 136 | 51        | 1.70 757 | 71        | 1.85 126 | 91         | 1.95 904 |
| 12        | 1.07 918 | 32        | 1.50 515 | 52        | 1.71 600 | 72        | 1.85 733 | 92         | 1.96 379 |
| 13        | 1.11 394 | 33        | 1.51 851 | 53        | 1.72 428 | 73        | 1.86 332 | 93         | 1.96 848 |
| 14        | 1.14 613 | 34        | 1.53 148 | 54        | 1.73 239 | 74        | 1.86 923 | 94         | 1.97 313 |
| 15        | 1.17 609 | 35        | 1.54 407 | 55        | 1.74 036 | 75        | 1.87 506 | 95         | 1.97 772 |
| 16        | 1.20 412 | 36        | 1.55 630 | 56        | 1.74 819 | 76        | 1.88 081 | 96         | 1.98 227 |
| 17        | 1.23 045 | 37        | 1.56 820 | 57        | 1.75 587 | 77        | 1.88 649 | 97         | 1.98 677 |
| 18        | 1.25 527 | 38        | 1.57 978 | 58        | 1.76 343 | 78        | 1.89 209 | 98         | 1.99 123 |
| 19        | 1.27 875 | 39        | 1.59 106 | 59        | 1.77 085 | 79        | 1.89 763 | 99         | 1.99 564 |
| <b>20</b> | 1.30 103 | <b>40</b> | 1.60 206 | <b>60</b> | 1.77 815 | <b>80</b> | 1.90 309 | <b>100</b> | 2.00 000 |

|    | S'.      | T'. |             | S''.     | T''. |
|----|----------|-----|-------------|----------|------|
| 0' | 6.46 373 | 373 | 0° 0' = 0'' | 4.68 557 | 557  |
| 1  | 373      | 373 | 0 1 = 60    | 557      | 557  |
|    |          |     | 0 2 = 120   | 557      | 557  |



| S'. T'.         | N.  | L. 0   | 1         | 2    | 3    | 4    | 5    | 6    | 7    | 8            | 9    | P. P.            |
|-----------------|-----|--------|-----------|------|------|------|------|------|------|--------------|------|------------------|
| 6.46<br>366 385 | 100 | 00 000 | 043       | 087  | 130  | 173  | 217  | 260  | 303  | 346          | 389  | 44 43 42         |
| 366 385 101     |     | 432    | 475       | 518  | 561  | 604  | 647  | 689  | 732  | 775          | 817  | 1 4.4 4.3 4.2    |
| 366 385 102     |     | 860    | 903       | 945  | 988  | 1030 | 1072 | 1115 | 1157 | 1199         | 1242 | 2 8.8 8.6 8.4    |
| 366 386 103     | 01  | 284    | 326       | 368  | 410  | 452  | 494  | 536  | 578  | 620          | 662  | 3 13.2 12.9 12.6 |
| 366 386 104     |     | 703    | 745       | 787  | 828  | 870  | 912  | 953  | 995  | 1036         | 1078 | 4 17.6 17.2 16.8 |
| 366 386 105     | 02  | 119    | 160       | 202  | 243  | 284  | 325  | 366  | 407  | 449          | 490  | 5 22.0 21.5 21.0 |
| 366 386 106     |     | 531    | 572       | 612  | 653  | 694  | 735  | 776  | 816  | 857          | 898  | 6 26.4 25.8 25.2 |
| 366 387 107     |     | 938    | 979       | 1019 | 1060 | 1100 | 1141 | 1181 | 1222 | 1262         | 1302 | 7 30.8 30.1 29.4 |
| 365 387 108     | 03  | 342    | 383       | 423  | 463  | 503  | 543  | 583  | 623  | 663          | 703  | 8 35.2 34.4 33.6 |
| 365 387 109     |     | 743    | 782       | 822  | 862  | 902  | 941  | 981  | 1021 | 1060         | 1100 | 9 39.6 38.7 37.8 |
| 365 387 110     | 04  | 139    | 179       | 218  | 258  | 297  | 336  | 376  | 415  | 454          | 493  | 41 40 39         |
| 365 388 111     |     | 532    | 571       | 610  | 650  | 689  | 727  | 766  | 805  | 844          | 883  | 1 4.1 4.0 3.9    |
| 365 388 112     |     | 922    | 961       | 999  | 1038 | 1077 | 1115 | 1154 | 1192 | 1231         | 1269 | 2 8.2 8.0 7.8    |
| 365 388 113     | 05  | 308    | 346       | 385  | 423  | 461  | 500  | 538  | 576  | 614          | 652  | 3 12.3 12.0 11.7 |
| 365 389 114     |     | 690    | 729       | 767  | 805  | 843  | 881  | 918  | 956  | 994          | 1032 | 4 16.4 16.0 15.6 |
| 365 389 115     | 06  | 070    | 108       | 145  | 183  | 221  | 258  | 296  | 333  | 371          | 408  | 5 20.5 20.0 19.5 |
| 364 389 116     |     | 446    | 483       | 521  | 558  | 595  | 633  | 670  | 707  | 744          | 781  | 6 24.6 24.0 23.4 |
| 364 389 117     |     | 819    | 856       | 893  | 930  | 967  | 1004 | 1041 | 1078 | 1115         | 1151 | 7 28.7 28.0 27.3 |
| 364 390 118     | 07  | 188    | 225       | 262  | 298  | 335  | 372  | 408  | 445  | 482          | 518  | 8 32.8 32.0 31.2 |
| 364 390 119     |     | 553    | 591       | 628  | 664  | 700  | 737  | 773  | 809  | 846          | 882  | 9 36.9 36.0 35.1 |
| 364 390 120     |     | 918    | 954       | 990  | 1027 | 1063 | 1099 | 1135 | 1171 | 1207         | 1243 | 38 37 36         |
| 364 391 121     | 08  | 279    | 314       | 350  | 386  | 422  | 458  | 493  | 529  | 565          | 600  | 1 3.8 3.7 3.6    |
| 363 391 122     |     | 636    | 672       | 707  | 743  | 778  | 814  | 849  | 884  | 920          | 955  | 2 7.6 7.4 7.2    |
| 363 391 123     |     | 991    | 1026      | 1061 | 1096 | 1132 | 1167 | 1202 | 1237 | 1272         | 1307 | 3 11.4 11.1 10.8 |
| 363 391 124     | 09  | 342    | 377       | 412  | 447  | 482  | 517  | 552  | 587  | 621          | 656  | 4 15.2 14.8 14.4 |
| 363 391 125     |     | 691    | 726       | 760  | 795  | 830  | 864  | 899  | 934  | 968          | 1003 | 5 19.0 18.5 18.0 |
| 363 392 126     | 10  | 037    | 072       | 106  | 140  | 175  | 209  | 243  | 278  | 312          | 346  | 6 22.8 22.2 21.6 |
| 363 392 127     |     | 380    | 415       | 449  | 483  | 517  | 551  | 585  | 619  | 653          | 687  | 7 26.6 25.9 25.2 |
| 363 392 128     |     | 721    | 755       | 789  | 823  | 857  | 890  | 924  | 958  | 992          | 1025 | 8 30.4 29.6 28.8 |
| 362 392 129     | 11  | 059    | 093       | 126  | 160  | 193  | 227  | 261  | 294  | 327          | 361  | 9 34.2 33.3 32.4 |
| 362 393 130     |     | 394    | 428       | 461  | 494  | 528  | 561  | 594  | 628  | 661          | 694  | 35 34 33         |
| 362 393 131     |     | 727    | 760       | 793  | 826  | 860  | 893  | 926  | 959  | 992          | 1024 | 1 3.5 3.4 3.3    |
| 362 393 132     | 12  | 057    | 090       | 123  | 156  | 189  | 222  | 254  | 287  | 320          | 352  | 2 7.0 6.8 6.6    |
| 362 393 133     |     | 385    | 418       | 450  | 483  | 516  | 548  | 581  | 613  | 646          | 678  | 3 10.5 10.2 9.9  |
| 362 395 134     |     | 710    | 743       | 775  | 808  | 840  | 872  | 903  | 937  | 969          | 1001 | 4 14.0 13.6 13.2 |
| 361 395 135     | 13  | 033    | 066       | 098  | 130  | 162  | 194  | 226  | 258  | 290          | 322  | 5 17.5 17.0 16.5 |
| 361 395 136     |     | 354    | 386       | 418  | 450  | 481  | 513  | 545  | 577  | 609          | 640  | 6 21.0 20.4 19.8 |
| 361 396 137     |     | 672    | 704       | 735  | 767  | 799  | 830  | 862  | 893  | 925          | 956  | 7 24.5 23.8 23.1 |
| 361 396 138     |     | 988    | 1019      | 1051 | 1082 | 1114 | 1145 | 1176 | 1208 | 1239         | 1270 | 8 28.0 27.2 26.4 |
| 361 396 139     | 14  | 301    | 333       | 364  | 395  | 426  | 457  | 489  | 520  | 551          | 582  | 9 31.5 30.6 29.7 |
| 361 397 140     |     | 613    | 644       | 675  | 706  | 737  | 768  | 799  | 829  | 860          | 891  | 32 31 30         |
| 360 397 141     |     | 922    | 953       | 983  | 1014 | 1045 | 1076 | 1106 | 1137 | 1168         | 1198 | 1 3.2 3.1 3.0    |
| 360 397 142     | 15  | 229    | 259       | 290  | 320  | 351  | 381  | 412  | 442  | 473          | 503  | 2 6.4 6.2 6.0    |
| 360 398 143     |     | 534    | 564       | 594  | 625  | 655  | 685  | 715  | 746  | 776          | 806  | 3 9.6 9.3 9.0    |
| 360 398 144     |     | 836    | 866       | 897  | 927  | 957  | 987  | 1017 | 1047 | 1077         | 1107 | 4 12.8 12.4 12.0 |
| 360 398 145     | 16  | 137    | 167       | 197  | 227  | 256  | 286  | 316  | 346  | 376          | 406  | 5 16.0 15.5 15.0 |
| 360 399 146     |     | 435    | 465       | 495  | 524  | 554  | 584  | 613  | 643  | 673          | 702  | 6 19.2 18.6 18.0 |
| 359 399 147     |     | 732    | 761       | 791  | 820  | 850  | 879  | 909  | 938  | 967          | 997  | 7 22.4 21.7 21.0 |
| 359 399 148     | 17  | 025    | 056       | 085  | 114  | 143  | 173  | 202  | 231  | 260          | 289  | 8 25.6 24.8 24.0 |
| 359 400 149     |     | 319    | 348       | 377  | 406  | 435  | 464  | 493  | 522  | 551          | 580  | 9 28.8 27.9 27.0 |
| 359 400 150     |     | 609    | 638       | 667  | 696  | 725  | 754  | 782  | 811  | 840          | 869  |                  |
| S'. T'.         | N.  | L. 0   | 1         | 2    | 3    | 4    | 5    | 6    | 7    | 8            | 9    | P. P.            |
| S.// T.//       |     |        |           |      |      |      |      |      |      |              |      | S.// T.//        |
| I' 6.46 373 373 |     | 0°     | I' = 60'' | 4.68 | 557  | 557  |      |      | 0°   | 19' = 1140'' | 4.68 | 557 558          |
| 2 373 373       |     | 0      | 2 = 120   |      | 557  | 557  |      |      | 0    | 20 = 1200    |      | 557 558          |
| 10 373 373      |     | 0      | 3 = 180   |      | 557  | 557  |      |      | 0    | 21 = 1260    |      | 557 558          |
| 13 373 373      |     | 0      | 16 = 960  |      | 557  | 558  |      |      | 0    | 22 = 1320    |      | 557 558          |
| 14 372 373      |     | 0      | 17 = 1020 |      | 557  | 558  |      |      | 0    | 23 = 1380    |      | 557 558          |
| 15 372 373      |     | 0      | 18 = 1080 |      | 557  | 558  |      |      | 0    | 24 = 1440    |      | 557 558          |
|                 |     | 0      | 19 = 1140 |      | 557  | 558  |      |      | 0    | 25 = 1500    |      | 557 558          |

| S' T'.  | N.  | L. 0   | 1   | 2         | 3    | 4    | 5    | 6    | 7           | 8    | 9    | P. P.       |
|---------|-----|--------|-----|-----------|------|------|------|------|-------------|------|------|-------------|
| 359 400 | 150 | 17 609 | 638 | 667       | 696  | 725  | 754  | 782  | 811         | 840  | 869  | 29 28       |
| 359 401 | 151 | 898    | 926 | 955       | 984  | *013 | *041 | *070 | *099        | *127 | *156 | 1 2.9 2.8   |
| 359 402 | 152 | 18 184 | 213 | 241       | 270  | 298  | 327  | 355  | 384         | 412  | 441  | 2 5.3 5.6   |
| 358 401 | 153 | 469    | 498 | 526       | 554  | 583  | 611  | 639  | 667         | 696  | 724  | 3 8.7 8.4   |
| 358 402 | 154 | 752    | 780 | 808       | 837  | 865  | 893  | 921  | 949         | 977  | *005 | 4 11.6 11.2 |
| 358 402 | 155 | 19 033 | 061 | 089       | 117  | 145  | 173  | 201  | 229         | 257  | 285  | 5 14.5 14.0 |
| 358 402 | 156 | 312    | 340 | 368       | 396  | 424  | 451  | 479  | 507         | 535  | 562  | 6 17.4 16.8 |
| 358 403 | 157 | 590    | 618 | 645       | 673  | 700  | 728  | 756  | 783         | 811  | 838  | 7 20.3 19.6 |
| 357 403 | 158 | 866    | 893 | 921       | 948  | 976  | *003 | *030 | *058        | *085 | *112 | 8 23.2 22.4 |
| 357 404 | 159 | 20 140 | 167 | 194       | 222  | 249  | 276  | 303  | 330         | 358  | 385  | 9 26.1 25.2 |
| 357 404 | 160 | 412    | 439 | 466       | 493  | 520  | 548  | 575  | 602         | 629  | 656  | 27 26       |
| 357 404 | 161 | 683    | 710 | 737       | 763  | 790  | 817  | 844  | 871         | 898  | 925  | 1 2.7 2.6   |
| 357 405 | 162 | 952    | 978 | *005      | *032 | *059 | *085 | *112 | *139        | *165 | *192 | 2 5.4 5.2   |
| 356 405 | 163 | 21 219 | 245 | 272       | 299  | 325  | 352  | 378  | 405         | 431  | 458  | 3 8.1 7.8   |
| 356 406 | 164 | 484    | 511 | 537       | 564  | 590  | 617  | 643  | 669         | 696  | 722  | 4 10.8 10.4 |
| 356 406 | 165 | 748    | 775 | 801       | 827  | 854  | 880  | 906  | 932         | 958  | 985  | 5 13.5 13.0 |
| 356 406 | 166 | 22 011 | 037 | 063       | 089  | 115  | 141  | 167  | 194         | 220  | 246  | 6 16.2 15.6 |
| 356 407 | 167 | 272    | 298 | 324       | 350  | 376  | 401  | 427  | 453         | 479  | 505  | 7 18.9 18.2 |
| 355 407 | 168 | 531    | 557 | 583       | 608  | 634  | 660  | 686  | 712         | 737  | 763  | 8 21.6 20.8 |
| 355 408 | 169 | 780    | 814 | 840       | 866  | 891  | 917  | 943  | 968         | 994  | *019 | 9 24.3 23.4 |
| 355 408 | 170 | 23 045 | 070 | 096       | 121  | 147  | 172  | 198  | 223         | 249  | 274  | 25          |
| 355 408 | 171 | 300    | 325 | 350       | 376  | 401  | 426  | 452  | 477         | 502  | 528  | 1 2.5       |
| 354 409 | 172 | 553    | 578 | 603       | 629  | 654  | 679  | 704  | 729         | 754  | 779  | 2 5.0       |
| 354 409 | 173 | 805    | 830 | 855       | 880  | 905  | 930  | 955  | 980         | *005 | *030 | 3 7.5       |
| 354 410 | 174 | 24 053 | 080 | 105       | 130  | 155  | 180  | 204  | 229         | 254  | 279  | 4 10.0      |
| 354 410 | 175 | 304    | 329 | 353       | 378  | 403  | 428  | 452  | 477         | 502  | 527  | 5 12.5      |
| 354 411 | 176 | 551    | 576 | 601       | 625  | 650  | 674  | 699  | 724         | 748  | 773  | 6 15.0      |
| 353 411 | 177 | 797    | 822 | 846       | 871  | 895  | 920  | 944  | 969         | 993  | *018 | 7 17.5      |
| 353 411 | 178 | 25 042 | 066 | 091       | 115  | 139  | 164  | 188  | 212         | 237  | 261  | 8 20.0      |
| 353 412 | 179 | 285    | 310 | 334       | 358  | 382  | 406  | 431  | 455         | 479  | 503  | 9 22.5      |
| 353 412 | 180 | 527    | 551 | 575       | 600  | 624  | 648  | 672  | 696         | 720  | 744  | 24 23       |
| 353 413 | 181 | 768    | 792 | 816       | 840  | 864  | 888  | 912  | 935         | 959  | 983  | 1 2.4 2.3   |
| 352 413 | 182 | 26 007 | 031 | 055       | 079  | 102  | 126  | 150  | 174         | 198  | 222  | 2 4.8 4.6   |
| 352 414 | 183 | 245    | 269 | 293       | 316  | 340  | 364  | 387  | 411         | 435  | 458  | 3 7.2 6.9   |
| 352 414 | 184 | 482    | 505 | 529       | 553  | 576  | 600  | 623  | 647         | 670  | 694  | 4 9.6 9.2   |
| 352 415 | 185 | 717    | 741 | 764       | 788  | 811  | 834  | 858  | 881         | 905  | 928  | 5 12.0 11.5 |
| 351 415 | 186 | 951    | 975 | 998       | *021 | *045 | *068 | *091 | *114        | *138 | *161 | 6 14.4 13.8 |
| 351 415 | 187 | 27 184 | 207 | 231       | 254  | 277  | 300  | 323  | 346         | 370  | 393  | 7 16.8 16.1 |
| 351 416 | 188 | 416    | 439 | 462       | 485  | 508  | 531  | 554  | 577         | 600  | 623  | 8 19.2 18.4 |
| 351 416 | 189 | 646    | 669 | 692       | 715  | 738  | 761  | 784  | 807         | 830  | 853  | 9 21.6 20.7 |
| 350 417 | 190 | 875    | 898 | 921       | 944  | 967  | 989  | *012 | *035        | *058 | *081 | 22 21       |
| 350 417 | 191 | 28 103 | 126 | 149       | 171  | 194  | 217  | 240  | 262         | 285  | 307  | 1 2.2 2.1   |
| 350 418 | 192 | 330    | 353 | 375       | 398  | 421  | 443  | 466  | 488         | 511  | 533  | 2 4.4 4.2   |
| 350 418 | 193 | 556    | 578 | 601       | 623  | 646  | 668  | 691  | 713         | 735  | 758  | 3 6.6 6.3   |
| 350 419 | 194 | 780    | 803 | 825       | 847  | 870  | 892  | 914  | 937         | 959  | 981  | 4 8.8 8.4   |
| 349 419 | 195 | 29 003 | 026 | 048       | 070  | 092  | 115  | 137  | 159         | 181  | 203  | 5 11.0 10.5 |
| 349 420 | 196 | 226    | 248 | 270       | 292  | 314  | 336  | 358  | 380         | 403  | 425  | 6 13.2 12.6 |
| 349 420 | 197 | 447    | 469 | 491       | 513  | 535  | 557  | 579  | 601         | 623  | 645  | 7 15.4 14.7 |
| 349 421 | 198 | 667    | 688 | 710       | 732  | 754  | 776  | 798  | 820         | 842  | 863  | 8 17.6 16.8 |
| 348 421 | 199 | 885    | 907 | 929       | 951  | 973  | 994  | *016 | *038        | *060 | *081 | 9 19.8 18.9 |
| 348 422 | 200 | 30 103 | 125 | 146       | 168  | 190  | 211  | 233  | 255         | 276  | 298  |             |
| S' T'.  | N.  | L. 0   | 1   | 2         | 3    | 4    | 5    | 6    | 7           | 8    | 9    | P. P.       |
| 1' 6.46 | 373 | 373    | 0°  | 2' = 120" | 4.68 | 557  | 557  | 0°   | 28' = 1680" | 4.68 | 557  | 558         |
| 2       | 373 | 373    | 0   | 3 = 180   |      | 557  | 557  | 0    | 29 = 1740   |      | 557  | 559         |
| 15      | 372 | 373    | 0   | 4 = 240   |      | 557  | 558  | 0    | 30 = 1800   |      | 557  | 559         |
| 20      | 372 | 373    | 0   | 25 = 1500 |      | 557  | 558  | 0    | 31 = 1860   |      | 557  | 559         |
|         |     |        | 0   | 26 = 1560 |      | 557  | 558  | 0    | 32 = 1920   |      | 557  | 559         |
|         |     |        | 0   | 27 = 1620 |      | 557  | 558  | 0    | 33 = 1980   |      | 557  | 559         |
|         |     |        | 0   | 28 = 1680 |      | 557  | 558  | 0    | 34 = 2040   |      | 557  | 559         |

| N.  | L.   | 0   | 1    | 2    | 3          | 4    | 5    | 6    | 7    | 8            | 9    | P. P. |           |
|-----|------|-----|------|------|------------|------|------|------|------|--------------|------|-------|-----------|
| 200 | 30   | 103 | 125  | 146  | 168        | 190  | 211  | 233  | 255  | 276          | 298  | 22    | 21        |
| 201 |      | 320 | 341  | 363  | 384        | 406  | 428  | 449  | 471  | 492          | 514  | 1     | 2.2 2.1   |
| 202 |      | 535 | 557  | 578  | 600        | 621  | 643  | 664  | 685  | 707          | 728  | 2     | 4.4 4.2   |
| 203 |      | 750 | 771  | 792  | 814        | 835  | 856  | 878  | 899  | 920          | 942  | 3     | 6.6 6.3   |
| 204 |      | 963 | 984  | *006 | *027       | *048 | *069 | *091 | *112 | *133         | *154 | 4     | 8.8 8.4   |
| 205 | 31   | 175 | 197  | 218  | 239        | 260  | 281  | 302  | 323  | 345          | 366  | 5     | 11.0 10.5 |
| 206 |      | 387 | 408  | 429  | 450        | 471  | 492  | 513  | 534  | 555          | 576  | 6     | 13.2 12.6 |
| 207 |      | 597 | 618  | 639  | 660        | 681  | 702  | 723  | 744  | 765          | 785  | 7     | 15.4 14.7 |
| 208 |      | 806 | 827  | 848  | 869        | 890  | 911  | 931  | 952  | 973          | 994  | 8     | 17.6 16.8 |
| 209 | 32   | 015 | 035  | 056  | 077        | 098  | 118  | 139  | 160  | 181          | 201  | 9     | 19.8 18.9 |
| 210 |      | 222 | 243  | 263  | 284        | 305  | 325  | 346  | 366  | 387          | 408  |       | 20        |
| 211 |      | 428 | 449  | 469  | 490        | 510  | 531  | 552  | 572  | 593          | 613  | 1     | 2.0       |
| 212 |      | 634 | 654  | 675  | 695        | 715  | 736  | 756  | 777  | 797          | 818  | 2     | 4.0       |
| 213 |      | 838 | 858  | 879  | 899        | 919  | 940  | 960  | 980  | *001         | *021 | 3     | 6.0       |
| 214 | 33   | 041 | 062  | 082  | 102        | 122  | 143  | 163  | 183  | 203          | 224  | 4     | 8.0       |
| 215 |      | 244 | 264  | 284  | 304        | 325  | 345  | 365  | 385  | 405          | 425  | 5     | 10.0      |
| 216 |      | 445 | 465  | 486  | 506        | 526  | 546  | 566  | 586  | 606          | 626  | 6     | 12.0      |
| 217 |      | 646 | 666  | 686  | 706        | 726  | 746  | 766  | 786  | 806          | 826  | 7     | 14.0      |
| 218 |      | 846 | 866  | 885  | 905        | 925  | 945  | 965  | 985  | *005         | *025 | 8     | 16.0      |
| 219 | 34   | 044 | 064  | 084  | 104        | 124  | 143  | 163  | 183  | 203          | 223  | 9     | 18.0      |
| 220 |      | 242 | 262  | 282  | 301        | 321  | 341  | 361  | 380  | 400          | 420  |       | 19        |
| 221 |      | 439 | 459  | 479  | 498        | 518  | 537  | 557  | 577  | 596          | 616  | 1     | 1.9       |
| 222 |      | 635 | 655  | 674  | 694        | 713  | 733  | 753  | 772  | 792          | 811  | 2     | 3.8       |
| 223 |      | 830 | 850  | 869  | 889        | 908  | 928  | 947  | 967  | 986          | *005 | 3     | 5.7       |
| 224 | 35   | 025 | 044  | 064  | 083        | 102  | 122  | 141  | 160  | 180          | 199  | 4     | 7.6       |
| 225 |      | 218 | 238  | 257  | 276        | 295  | 315  | 334  | 353  | 372          | 392  | 5     | 9.5       |
| 226 |      | 411 | 430  | 449  | 468        | 488  | 507  | 526  | 545  | 564          | 583  | 6     | 11.4      |
| 227 |      | 603 | 622  | 641  | 660        | 679  | 698  | 717  | 736  | 755          | 774  | 7     | 13.3      |
| 228 |      | 793 | 813  | 832  | 851        | 870  | 889  | 908  | 927  | 946          | 965  | 8     | 15.2      |
| 229 |      | 984 | *003 | *021 | *040       | *059 | *078 | *097 | *116 | *135         | *154 | 9     | 17.1      |
| 230 | 36   | 173 | 192  | 211  | 229        | 248  | 267  | 286  | 305  | 324          | 342  |       | 18        |
| 231 |      | 361 | 380  | 399  | 418        | 436  | 455  | 474  | 493  | 511          | 530  | 1     | 1.8       |
| 232 |      | 549 | 568  | 586  | 605        | 624  | 642  | 661  | 680  | 698          | 717  | 2     | 3.6       |
| 233 |      | 736 | 754  | 773  | 791        | 810  | 829  | 847  | 866  | 884          | 903  | 3     | 5.4       |
| 234 |      | 922 | 940  | 959  | 977        | 996  | *014 | *033 | *051 | *070         | *088 | 4     | 7.2       |
| 235 | 37   | 107 | 125  | 144  | 162        | 181  | 199  | 218  | 236  | 254          | 273  | 5     | 9.0       |
| 236 |      | 291 | 310  | 328  | 346        | 365  | 383  | 401  | 420  | 438          | 457  | 6     | 10.8      |
| 237 |      | 475 | 493  | 511  | 530        | 548  | 566  | 585  | 603  | 621          | 639  | 7     | 12.6      |
| 238 |      | 658 | 676  | 694  | 712        | 731  | 749  | 767  | 785  | 803          | 822  | 8     | 14.4      |
| 239 |      | 840 | 858  | 876  | 894        | 912  | 931  | 949  | 967  | 985          | *003 | 9     | 16.2      |
| 240 | 38   | 021 | 039  | 057  | 075        | 093  | 112  | 130  | 148  | 166          | 184  |       | 17        |
| 241 |      | 202 | 220  | 238  | 256        | 274  | 292  | 310  | 328  | 346          | 364  | 1     | 1.7       |
| 242 |      | 382 | 399  | 417  | 435        | 453  | 471  | 489  | 507  | 525          | 543  | 2     | 3.4       |
| 243 |      | 561 | 578  | 596  | 614        | 632  | 650  | 668  | 686  | 703          | 721  | 3     | 5.1       |
| 244 |      | 739 | 757  | 775  | 792        | 810  | 828  | 846  | 863  | 881          | 899  | 4     | 6.8       |
| 245 |      | 917 | 934  | 952  | 970        | 987  | *005 | *023 | *041 | *058         | *076 | 5     | 8.5       |
| 246 | 39   | 094 | 111  | 129  | 146        | 164  | 182  | 199  | 217  | 235          | 252  | 6     | 10.2      |
| 247 |      | 270 | 287  | 305  | 322        | 340  | 358  | 375  | 393  | 410          | 428  | 7     | 11.9      |
| 248 |      | 445 | 463  | 480  | 498        | 515  | 533  | 550  | 568  | 585          | 602  | 8     | 13.6      |
| 249 |      | 620 | 637  | 655  | 672        | 690  | 707  | 724  | 742  | 759          | 777  | 9     | 15.3      |
| 250 |      | 794 | 811  | 829  | 846        | 863  | 881  | 898  | 915  | 933          | 950  |       |           |
| N.  | L.   | 0   | 1    | 2    | 3          | 4    | 5    | 6    | 7    | 8            | 9    | P. P. |           |
|     |      | S.' | T.'  | S.'' |            |      |      | T.'' | S.'' |              |      |       | T.''      |
| 2'  | 6.46 | 373 | 373  | 0°   | 3' = 180'' | 4.68 | 557  | 557  | 0°   | 36' = 2160'' | 4.68 | 557   | 559       |
| 3   |      | 373 | 373  | 0    | 4 = 240    |      | 557  | 558  | 0    | 37 = 2220    |      | 557   | 559       |
|     |      | 372 | 373  | 0    | 5 = 300    |      | 557  | 558  | 0    | 38 = 2280    |      | 557   | 559       |
| 25  |      | 372 | 373  | 0    | 33 = 1980  |      | 557  | 559  | 0    | 39 = 2340    |      | 557   | 559       |
|     |      |     |      | 0    | 34 = 2040  |      | 557  | 559  | 0    | 40 = 2400    |      | 557   | 559       |
|     |      |     |      | 0    | 35 = 2100  |      | 557  | 559  | 0    | 41 = 2460    |      | 556   | 560       |
|     |      |     |      | 0    | 36 = 2160  |      | 557  | 559  | 0    | 42 = 2520    |      | 556   | 560       |

| N.  | L.   | 0   | 1    | 2    | 3         | 4    | 5    | 6    | 7    | 8           | 9    | P. P.  |     |
|-----|------|-----|------|------|-----------|------|------|------|------|-------------|------|--------|-----|
| 250 | 39   | 794 | 811  | 829  | 846       | 863  | 881  | 898  | 915  | 933         | 950  |        |     |
| 251 |      | 967 | 985  | *002 | *019      | *037 | *054 | *071 | *088 | *106        | *123 | 18     |     |
| 252 | 40   | 140 | 157  | 175  | 192       | 209  | 226  | 243  | 261  | 278         | 295  | 1 1.8  |     |
| 253 |      | 312 | 329  | 346  | 364       | 381  | 398  | 415  | 432  | 449         | 466  | 2 3.6  |     |
| 254 |      | 483 | 500  | 518  | 535       | 552  | 569  | 586  | 603  | 620         | 637  | 3 5.4  |     |
| 255 |      | 654 | 671  | 688  | 705       | 722  | 739  | 756  | 773  | 790         | 807  | 4 7.2  |     |
| 256 |      | 824 | 841  | 858  | 875       | 892  | 909  | 926  | 943  | 960         | 976  | 5 9.0  |     |
| 257 |      | 993 | *010 | *027 | *044      | *061 | *078 | *095 | *111 | *128        | *145 | 6 10.8 |     |
| 258 | 41   | 162 | 179  | 196  | 212       | 229  | 246  | 263  | 280  | 296         | 313  | 7 12.6 |     |
| 259 |      | 330 | 347  | 363  | 380       | 397  | 414  | 430  | 447  | 464         | 481  | 8 14.4 |     |
| 260 |      | 497 | 514  | 531  | 547       | 564  | 581  | 597  | 614  | 631         | 647  | 9 16.2 |     |
| 261 |      | 664 | 681  | 697  | 714       | 731  | 747  | 764  | 780  | 797         | 814  | 17     |     |
| 262 |      | 830 | 847  | 863  | 880       | 896  | 913  | 929  | 946  | 963         | 979  | 1 1.7  |     |
| 263 |      | 996 | *012 | *029 | *045      | *062 | *078 | *095 | *111 | *127        | *144 | 2 3.4  |     |
| 264 | 42   | 160 | 177  | 193  | 210       | 226  | 243  | 259  | 275  | 292         | 308  | 3 5.1  |     |
| 265 |      | 325 | 341  | 357  | 374       | 390  | 406  | 423  | 439  | 455         | 472  | 4 6.8  |     |
| 266 |      | 488 | 504  | 521  | 537       | 553  | 570  | 586  | 602  | 619         | 635  | 5 8.5  |     |
| 267 |      | 651 | 667  | 684  | 700       | 716  | 732  | 749  | 765  | 781         | 797  | 6 10.2 |     |
| 268 |      | 813 | 830  | 846  | 862       | 878  | 894  | 911  | 927  | 943         | 959  | 7 11.9 |     |
| 269 |      | 975 | 991  | *008 | *024      | *040 | *056 | *072 | *088 | *104        | *120 | 8 13.6 |     |
| 270 | 43   | 136 | 152  | 169  | 185       | 201  | 217  | 233  | 249  | 265         | 281  | 9 15.3 |     |
| 271 |      | 297 | 313  | 329  | 345       | 361  | 377  | 393  | 409  | 425         | 441  | 16     |     |
| 272 |      | 457 | 473  | 489  | 505       | 521  | 537  | 553  | 569  | 584         | 600  | 1 1.6  |     |
| 273 |      | 616 | 632  | 648  | 664       | 680  | 696  | 712  | 727  | 743         | 759  | 2 3.2  |     |
| 274 |      | 775 | 791  | 807  | 823       | 838  | 854  | 870  | 886  | 902         | 917  | 3 4.8  |     |
| 275 |      | 933 | 949  | 965  | 981       | 996  | *012 | *028 | *044 | *059        | *075 | 4 6.4  |     |
| 276 | 44   | 091 | 107  | 122  | 138       | 154  | 170  | 185  | 201  | 217         | 232  | 5 8.0  |     |
| 277 |      | 248 | 264  | 279  | 295       | 311  | 326  | 342  | 358  | 373         | 389  | 6 9.6  |     |
| 278 |      | 404 | 420  | 436  | 451       | 467  | 483  | 498  | 514  | 529         | 545  | 7 11.2 |     |
| 279 |      | 560 | 576  | 592  | 607       | 623  | 638  | 654  | 669  | 685         | 700  | 8 12.8 |     |
| 280 |      | 716 | 731  | 747  | 762       | 778  | 793  | 809  | 824  | 840         | 855  | 9 14.4 |     |
| 281 |      | 871 | 886  | 902  | 917       | 932  | 948  | 963  | 979  | 994         | *010 | 15     |     |
| 282 | 45   | 025 | 040  | 056  | 071       | 086  | 102  | 117  | 133  | 148         | 163  | 1 1.5  |     |
| 283 |      | 179 | 194  | 209  | 225       | 240  | 255  | 271  | 286  | 301         | 317  | 2 3.0  |     |
| 284 |      | 332 | 347  | 362  | 378       | 393  | 408  | 423  | 439  | 454         | 469  | 3 4.5  |     |
| 285 |      | 484 | 500  | 515  | 530       | 545  | 561  | 576  | 591  | 606         | 621  | 4 6.0  |     |
| 286 |      | 637 | 652  | 667  | 682       | 697  | 712  | 728  | 743  | 758         | 773  | 5 7.5  |     |
| 287 |      | 788 | 803  | 818  | 834       | 849  | 864  | 879  | 894  | 909         | 924  | 6 9.0  |     |
| 288 |      | 939 | 954  | 969  | 984       | *000 | *015 | *030 | *045 | *060        | *075 | 7 10.5 |     |
| 289 | 46   | 090 | 105  | 120  | 135       | 150  | 165  | 180  | 195  | 210         | 225  | 8 12.0 |     |
| 290 |      | 240 | 255  | 270  | 285       | 300  | 315  | 330  | 345  | 359         | 374  | 9 13.5 |     |
| 291 |      | 389 | 404  | 419  | 434       | 449  | 464  | 479  | 494  | 509         | 523  | 14     |     |
| 292 |      | 538 | 553  | 568  | 583       | 598  | 613  | 627  | 642  | 657         | 672  | 1 1.4  |     |
| 293 |      | 687 | 702  | 716  | 731       | 746  | 761  | 776  | 790  | 805         | 820  | 2 2.8  |     |
| 294 |      | 835 | 850  | 864  | 879       | 894  | 909  | 923  | 938  | 953         | 967  | 3 4.2  |     |
| 295 |      | 982 | 997  | *012 | *026      | *041 | *056 | *070 | *085 | *100        | *114 | 4 5.6  |     |
| 296 | 47   | 129 | 144  | 159  | 173       | 188  | 202  | 217  | 232  | 246         | 261  | 5 7.0  |     |
| 297 |      | 276 | 290  | 305  | 319       | 334  | 349  | 363  | 378  | 392         | 407  | 6 8.4  |     |
| 298 |      | 422 | 436  | 451  | 465       | 480  | 494  | 509  | 524  | 538         | 553  | 7 9.8  |     |
| 299 |      | 567 | 582  | 596  | 611       | 625  | 640  | 654  | 669  | 683         | 698  | 8 11.2 |     |
| 300 |      | 712 | 727  | 741  | 756       | 770  | 784  | 799  | 813  | 828         | 842  | 9 12.6 |     |
| N.  | L.   | 0   | 1    | 2    | 3         | 4    | 5    | 6    | 7    | 8           | 9    | P. P.  |     |
|     | S.   | T.  |      |      |           |      | S.   | T.   |      |             |      | S.     | T.  |
| 2'  | 6.46 | 373 | 373  | 0°   | 4' = 240" | 4.68 | 557  | 558  | 0°   | 45' = 2700" | 4.68 | 556    | 560 |
| 3   |      | 373 | 373  | 0    | 5 = 300   |      | 557  | 558  | 0    | 46 = 2760   |      | 556    | 560 |
| 25  |      | 372 | 373  | 0    | 41 = 2460 |      | 556  | 560  | 0    | 47 = 2820   |      | 556    | 560 |
| 26  |      | 372 | 373  | 0    | 42 = 2520 |      | 556  | 560  | 0    | 48 = 2880   |      | 556    | 560 |
| 27  |      | 372 | 374  | 0    | 43 = 2580 |      | 556  | 560  | 0    | 49 = 2940   |      | 556    | 560 |
| 30  |      | 372 | 374  | 0    | 44 = 2640 |      | 556  | 560  | 0    | 50 = 3000   |      | 556    | 561 |
|     |      |     |      | 0    | 45 = 2700 |      | 556  | 560  |      |             |      |        |     |

| N.  | L.   | 0       | 1    | 2    | 3    | 4    | 5             | 6    | 7    | 8    | 9    | P. P.           |      |     |     |
|-----|------|---------|------|------|------|------|---------------|------|------|------|------|-----------------|------|-----|-----|
| 300 | 47   | 712     | 727  | 741  | 756  | 770  | 784           | 799  | 813  | 828  | 842  |                 |      |     |     |
| 301 |      | 857     | 871  | 885  | 900  | 914  | 929           | 943  | 958  | 972  | 986  |                 |      |     |     |
| 302 | 48   | 001     | 015  | 029  | 044  | 058  | 073           | 087  | 101  | 116  | 130  |                 |      |     |     |
| 303 |      | 144     | 159  | 173  | 187  | 202  | 216           | 230  | 244  | 259  | 273  | 15              |      |     |     |
| 304 |      | 287     | 302  | 316  | 330  | 344  | 359           | 373  | 387  | 401  | 416  | 1               |      |     |     |
| 305 |      | 430     | 444  | 458  | 473  | 487  | 501           | 515  | 530  | 544  | 558  | 2               |      |     |     |
| 306 |      | 572     | 586  | 601  | 615  | 629  | 643           | 657  | 671  | 686  | 700  | 3               |      |     |     |
| 307 |      | 714     | 728  | 742  | 756  | 770  | 785           | 799  | 813  | 827  | 841  | 4               |      |     |     |
| 308 |      | 855     | 869  | 883  | 897  | 911  | 926           | 940  | 954  | 968  | 982  | 5               |      |     |     |
| 309 |      | 996     | *010 | *024 | *038 | *052 | *066          | *080 | *094 | *108 | *122 | 6               |      |     |     |
| 310 | 49   | 136     | 150  | 164  | 178  | 192  | 206           | 220  | 234  | 248  | 262  | 7               |      |     |     |
| 311 |      | 276     | 290  | 304  | 318  | 332  | 346           | 360  | 374  | 388  | 402  | 8               |      |     |     |
| 312 |      | 415     | 429  | 443  | 457  | 471  | 485           | 499  | 513  | 527  | 541  | 9               |      |     |     |
| 313 |      | 554     | 568  | 582  | 596  | 610  | 624           | 638  | 651  | 665  | 679  |                 |      |     |     |
| 314 |      | 693     | 707  | 721  | 734  | 748  | 762           | 776  | 790  | 803  | 817  |                 |      |     |     |
| 315 |      | 831     | 845  | 859  | 872  | 886  | 900           | 914  | 927  | 941  | 955  |                 |      |     |     |
| 316 |      | 969     | 982  | 996  | *010 | *024 | *037          | *051 | *065 | *079 | *092 | 14              |      |     |     |
| 317 | 50   | 106     | 120  | 133  | 147  | 161  | 174           | 188  | 202  | 215  | 229  | 1               |      |     |     |
| 318 |      | 243     | 256  | 270  | 284  | 297  | 311           | 325  | 338  | 352  | 365  | 2               |      |     |     |
| 319 |      | 379     | 393  | 406  | 420  | 433  | 447           | 461  | 474  | 488  | 501  | 3               |      |     |     |
| 320 |      | 515     | 529  | 542  | 556  | 569  | 583           | 596  | 610  | 623  | 637  | 4               |      |     |     |
| 321 |      | 651     | 664  | 678  | 691  | 705  | 718           | 732  | 745  | 759  | 772  | 5               |      |     |     |
| 322 |      | 786     | 799  | 813  | 826  | 840  | 853           | 866  | 880  | 893  | 907  | 6               |      |     |     |
| 323 |      | 920     | 934  | 947  | 961  | 974  | 987           | *001 | *014 | *028 | *041 | 7               |      |     |     |
| 324 | 51   | 055     | 068  | 081  | 095  | 108  | 121           | 135  | 148  | 162  | 175  | 8               |      |     |     |
| 325 |      | 188     | 202  | 215  | 228  | 242  | 255           | 268  | 282  | 295  | 308  | 9               |      |     |     |
| 326 |      | 322     | 335  | 348  | 362  | 375  | 388           | 402  | 415  | 428  | 441  |                 |      |     |     |
| 327 |      | 455     | 468  | 481  | 495  | 508  | 521           | 534  | 548  | 561  | 574  | 13              |      |     |     |
| 328 |      | 587     | 601  | 614  | 627  | 640  | 654           | 667  | 680  | 693  | 706  | 1               |      |     |     |
| 329 |      | 720     | 733  | 746  | 759  | 772  | 786           | 799  | 812  | 825  | 838  | 2               |      |     |     |
| 330 |      | 851     | 865  | 878  | 891  | 904  | 917           | 930  | 943  | 957  | 970  | 3               |      |     |     |
| 331 |      | 983     | 996  | *009 | *022 | *035 | *048          | *061 | *075 | *088 | *101 | 4               |      |     |     |
| 332 | 52   | 114     | 127  | 140  | 153  | 166  | 179           | 192  | 205  | 218  | 231  | 5               |      |     |     |
| 333 |      | 244     | 257  | 270  | 284  | 297  | 310           | 323  | 336  | 349  | 362  | 6               |      |     |     |
| 334 |      | 375     | 388  | 401  | 414  | 427  | 440           | 453  | 466  | 479  | 492  | 7               |      |     |     |
| 335 |      | 504     | 517  | 530  | 543  | 556  | 569           | 582  | 595  | 608  | 621  | 8               |      |     |     |
| 336 |      | 634     | 647  | 660  | 673  | 686  | 699           | 711  | 724  | 737  | 750  | 9               |      |     |     |
| 337 |      | 763     | 776  | 789  | 802  | 815  | 827           | 840  | 853  | 866  | 879  |                 |      |     |     |
| 338 |      | 892     | 905  | 917  | 930  | 943  | 956           | 969  | 982  | 994  | *007 |                 |      |     |     |
| 339 | 53   | 020     | 033  | 046  | 058  | 071  | 084           | 097  | 110  | 122  | 135  | 12              |      |     |     |
| 340 |      | 148     | 161  | 173  | 186  | 199  | 212           | 224  | 237  | 250  | 263  | 1               |      |     |     |
| 341 |      | 275     | 288  | 301  | 314  | 326  | 339           | 352  | 364  | 377  | 390  | 2               |      |     |     |
| 342 |      | 403     | 415  | 428  | 441  | 453  | 466           | 479  | 491  | 504  | 517  | 3               |      |     |     |
| 343 |      | 529     | 542  | 555  | 567  | 580  | 593           | 605  | 618  | 631  | 643  | 4               |      |     |     |
| 344 |      | 656     | 668  | 681  | 694  | 706  | 719           | 732  | 744  | 757  | 769  | 5               |      |     |     |
| 345 |      | 782     | 794  | 807  | 820  | 832  | 845           | 857  | 870  | 882  | 895  | 6               |      |     |     |
| 346 |      | 908     | 920  | 933  | 945  | 958  | 970           | 983  | 995  | *008 | *020 | 7               |      |     |     |
| 347 | 54   | 033     | 045  | 058  | 070  | 083  | 095           | 108  | 120  | 133  | 145  | 8               |      |     |     |
| 348 |      | 158     | 170  | 183  | 195  | 208  | 220           | 233  | 245  | 258  | 270  | 9               |      |     |     |
| 349 |      | 283     | 295  | 307  | 320  | 332  | 345           | 357  | 370  | 382  | 394  | 10.8            |      |     |     |
| 350 |      | 407     | 419  | 432  | 444  | 456  | 469           | 481  | 494  | 506  | 518  |                 |      |     |     |
| N.  | L.   | 0       | 1    | 2    | 3    | 4    | 5             | 6    | 7    | 8    | 9    | P. P.           |      |     |     |
|     |      | S.' T.' |      |      |      |      | S.' T.'       |      |      |      |      | S.' T.'         |      |     |     |
| 3'  | 6.46 | 373     | 373  |      |      |      | 0° 5' = 300'' | 4.68 | 557  | 558  |      | 0° 54' = 3240'' | 4.68 | 556 | 561 |
| 4   |      | 373     | 373  |      |      |      | 0 6 = 360     |      | 557  | 558  |      | 0 55 = 3300     |      | 556 | 561 |
| 30  |      | 372     | 374  |      |      |      | 0 50 = 3000   |      | 556  | 561  |      | 0 56 = 3360     |      | 556 | 561 |
| 35  |      | 372     | 374  |      |      |      | 0 51 = 3060   |      | 556  | 561  |      | 0 57 = 3420     |      | 555 | 561 |
|     |      |         |      |      |      |      | 0 52 = 3120   |      | 556  | 561  |      | 0 58 = 3480     |      | 555 | 562 |
|     |      |         |      |      |      |      | 0 53 = 3180   |      | 556  | 561  |      | 0 59 = 3540     |      | 555 | 562 |
|     |      |         |      |      |      |      | 0 54 = 3240   |      | 556  | 561  |      |                 |      |     |     |

| N.  | L.   | 0   | 1    | 2    | 3    | 4     | 5    | 6    | 7    | 8    | 9    | P. P.  |      |     |     |
|-----|------|-----|------|------|------|-------|------|------|------|------|------|--------|------|-----|-----|
| 350 | 54   | 407 | 419  | 432  | 444  | 456   | 469  | 481  | 494  | 506  | 518  |        |      |     |     |
| 351 |      | 531 | 543  | 555  | 568  | 580   | 593  | 605  | 617  | 630  | 642  |        |      |     |     |
| 352 |      | 654 | 667  | 679  | 691  | 704   | 716  | 728  | 741  | 753  | 765  | 13     |      |     |     |
| 353 |      | 777 | 790  | 802  | 814  | 827   | 839  | 851  | 864  | 876  | 888  | 1      |      |     |     |
| 354 |      | 900 | 913  | 925  | 937  | 949   | 962  | 974  | 986  | 998  | *011 | 2      |      |     |     |
| 355 | 55   | 023 | 035  | 047  | 060  | 072   | 084  | 096  | 108  | 121  | 133  | 3      |      |     |     |
| 356 |      | 145 | 157  | 169  | 182  | 194   | 206  | 218  | 230  | 242  | 255  | 4      |      |     |     |
| 357 |      | 267 | 279  | 291  | 303  | 315   | 328  | 340  | 352  | 364  | 376  | 5      |      |     |     |
| 358 |      | 388 | 400  | 413  | 425  | 437   | 449  | 461  | 473  | 485  | 497  | 6      |      |     |     |
| 359 |      | 509 | 522  | 534  | 546  | 558   | 570  | 582  | 594  | 606  | 618  | 7      |      |     |     |
| 360 |      | 630 | 642  | 654  | 666  | 678   | 691  | 703  | 715  | 727  | 739  | 8      |      |     |     |
| 361 |      | 751 | 763  | 775  | 787  | 799   | 811  | 823  | 835  | 847  | 859  | 9      |      |     |     |
| 362 |      | 871 | 883  | 895  | 907  | 919   | 931  | 943  | 955  | 967  | 979  |        |      |     |     |
| 363 |      | 991 | *003 | *015 | *027 | *038  | *050 | *062 | *074 | *086 | *098 |        |      |     |     |
| 364 | 56   | 110 | 122  | 134  | 146  | 158   | 170  | 182  | 194  | 205  | 217  | 12     |      |     |     |
| 365 |      | 229 | 241  | 253  | 265  | 277   | 289  | 301  | 312  | 324  | 336  | 1      |      |     |     |
| 366 |      | 348 | 360  | 372  | 384  | 396   | 407  | 419  | 431  | 443  | 455  | 2      |      |     |     |
| 367 |      | 467 | 478  | 490  | 502  | 514   | 526  | 538  | 549  | 561  | 573  | 3      |      |     |     |
| 368 |      | 585 | 597  | 608  | 620  | 632   | 644  | 656  | 667  | 679  | 691  | 4      |      |     |     |
| 369 |      | 703 | 714  | 726  | 738  | 750   | 761  | 773  | 785  | 797  | 808  | 5      |      |     |     |
| 370 |      | 820 | 832  | 844  | 855  | 867   | 879  | 891  | 902  | 914  | 926  | 6      |      |     |     |
| 371 |      | 937 | 949  | 961  | 972  | 984   | 996  | *008 | *019 | *031 | *043 | 7      |      |     |     |
| 372 | 57   | 054 | 066  | 078  | 089  | 101   | 113  | 124  | 136  | 148  | 159  | 8      |      |     |     |
| 373 |      | 171 | 183  | 194  | 206  | 217   | 229  | 241  | 252  | 264  | 276  | 9      |      |     |     |
| 374 |      | 287 | 299  | 310  | 322  | 334   | 345  | 357  | 368  | 380  | 392  |        |      |     |     |
| 375 |      | 403 | 415  | 426  | 438  | 449   | 461  | 473  | 484  | 496  | 507  |        |      |     |     |
| 376 |      | 519 | 530  | 542  | 553  | 565   | 576  | 588  | 600  | 611  | 623  |        |      |     |     |
| 377 |      | 634 | 646  | 657  | 669  | 680   | 692  | 703  | 715  | 726  | 738  | 11     |      |     |     |
| 378 |      | 749 | 761  | 772  | 784  | 795   | 807  | 818  | 830  | 841  | 852  | 1      |      |     |     |
| 379 |      | 864 | 875  | 887  | 898  | 910   | 921  | 933  | 944  | 955  | 967  | 2      |      |     |     |
| 380 |      | 978 | 990  | *001 | *013 | *024  | *035 | *047 | *058 | *070 | *081 | 3      |      |     |     |
| 381 | 58   | 092 | 104  | 115  | 127  | 138   | 149  | 161  | 172  | 184  | 195  | 4      |      |     |     |
| 382 |      | 206 | 218  | 229  | 240  | 252   | 263  | 274  | 286  | 297  | 309  | 5      |      |     |     |
| 383 |      | 320 | 331  | 343  | 354  | 365   | 377  | 388  | 399  | 410  | 422  | 6      |      |     |     |
| 384 |      | 433 | 444  | 456  | 467  | 478   | 490  | 501  | 512  | 524  | 535  | 7      |      |     |     |
| 385 |      | 546 | 557  | 569  | 580  | 591   | 602  | 614  | 625  | 636  | 647  | 8      |      |     |     |
| 386 |      | 659 | 670  | 681  | 692  | 704   | 715  | 726  | 737  | 749  | 760  | 9      |      |     |     |
| 387 |      | 771 | 782  | 794  | 805  | 816   | 827  | 838  | 850  | 861  | 872  |        |      |     |     |
| 388 |      | 883 | 894  | 906  | 917  | 928   | 939  | 950  | 961  | 973  | 984  |        |      |     |     |
| 389 |      | 995 | *006 | *017 | *028 | *040  | *051 | *062 | *073 | *084 | *095 |        |      |     |     |
| 390 | 59   | 106 | 118  | 129  | 140  | 151   | 162  | 173  | 184  | 195  | 207  | 10     |      |     |     |
| 391 |      | 218 | 229  | 240  | 251  | 262   | 273  | 284  | 295  | 306  | 318  | 1      |      |     |     |
| 392 |      | 329 | 340  | 351  | 362  | 373   | 384  | 395  | 406  | 417  | 428  | 2      |      |     |     |
| 393 |      | 439 | 450  | 461  | 472  | 483   | 494  | 506  | 517  | 528  | 539  | 3      |      |     |     |
| 394 |      | 550 | 561  | 572  | 583  | 594   | 605  | 616  | 627  | 638  | 649  | 4      |      |     |     |
| 395 |      | 660 | 671  | 682  | 693  | 704   | 715  | 726  | 737  | 748  | 759  | 5      |      |     |     |
| 396 |      | 770 | 780  | 791  | 802  | 813   | 824  | 835  | 846  | 857  | 868  | 6      |      |     |     |
| 397 |      | 879 | 890  | 901  | 912  | 923   | 934  | 945  | 956  | 967  | 977  | 7      |      |     |     |
| 398 |      | 988 | 999  | *010 | *021 | *032  | *043 | *054 | *065 | *076 | *086 | 8      |      |     |     |
| 399 | 60   | 097 | 108  | 119  | 130  | 141   | 152  | 163  | 173  | 184  | 195  | 9      |      |     |     |
| 400 |      | 206 | 217  | 228  | 239  | 249   | 260  | 271  | 282  | 293  | 304  |        |      |     |     |
| N.  | L.   | 0   | 1    | 2    | 3    | 4     | 5    | 6    | 7    | 8    | 9    | P. P.  |      |     |     |
|     | S./  | T./ |      |      |      |       | S./  | T./  |      |      |      | S./    | T./  |     |     |
| 3'  | 6.46 | 373 | 373  | 0°   | 5' = | 300'' | 4.68 | 557  | 558  | 1°   | 1' = | 3660'' | 4.68 | 555 | 562 |
| 4   |      | 373 | 373  | 0    | 6 =  | 360   |      | 557  | 558  | 1    | 2 =  | 3720   |      | 555 | 562 |
| 35  |      | 372 | 374  | 0    | 7 =  | 420   |      | 557  | 558  | 1    | 3 =  | 3780   |      | 555 | 562 |
| 39  |      | 372 | 374  | 0    | 58 = | 3480  |      | 555  | 562  | 1    | 4 =  | 3840   |      | 555 | 563 |
| 40  |      | 372 | 375  | 0    | 59 = | 3540  |      | 555  | 562  | 1    | 5 =  | 3900   |      | 555 | 563 |
|     |      |     |      | 1    | 0 =  | 3600  |      | 555  | 562  | 1    | 6 =  | 3960   |      | 555 | 563 |
|     |      |     |      | 1    | 1 =  | 3660  |      | 555  | 562  | 1    | 7 =  | 4020   |      | 555 | 563 |

| N.  | L.   | 0   | 1   | 2   | 3         | 4    | 5    | 6    | 7    | 8          | 9    | P. P. |     |
|-----|------|-----|-----|-----|-----------|------|------|------|------|------------|------|-------|-----|
| 400 | 60   | 206 | 217 | 228 | 239       | 249  | 260  | 271  | 282  | 293        | 304  |       |     |
| 401 |      | 314 | 325 | 336 | 347       | 358  | 369  | 379  | 390  | 401        | 412  |       |     |
| 402 |      | 423 | 433 | 444 | 455       | 466  | 477  | 487  | 498  | 509        | 520  |       |     |
| 403 |      | 531 | 541 | 552 | 563       | 574  | 584  | 595  | 606  | 617        | 627  |       |     |
| 404 |      | 638 | 649 | 660 | 670       | 681  | 692  | 703  | 713  | 724        | 735  |       |     |
| 405 |      | 746 | 756 | 767 | 778       | 788  | 799  | 810  | 821  | 831        | 842  |       |     |
| 406 |      | 853 | 863 | 874 | 885       | 895  | 906  | 917  | 927  | 938        | 949  | 11    |     |
| 407 |      | 959 | 970 | 981 | 991       | *002 | *013 | *023 | *034 | *045       | *055 | 1     |     |
| 408 | 61   | 066 | 077 | 087 | 098       | 109  | 119  | 130  | 140  | 151        | 162  | 2     |     |
| 409 |      | 172 | 183 | 194 | 204       | 215  | 225  | 236  | 247  | 257        | 268  | 3     |     |
| 410 |      | 278 | 289 | 300 | 310       | 321  | 331  | 342  | 352  | 363        | 374  | 4     |     |
| 411 |      | 384 | 395 | 405 | 416       | 426  | 437  | 448  | 458  | 469        | 479  | 5     |     |
| 412 |      | 490 | 500 | 511 | 521       | 532  | 542  | 553  | 563  | 574        | 584  | 6     |     |
| 413 |      | 595 | 606 | 616 | 627       | 637  | 648  | 658  | 669  | 679        | 690  | 7     |     |
| 414 |      | 700 | 711 | 721 | 731       | 742  | 752  | 763  | 773  | 784        | 794  | 8     |     |
| 415 |      | 805 | 815 | 826 | 836       | 847  | 857  | 868  | 878  | 888        | 899  | 9     |     |
| 416 |      | 909 | 920 | 930 | 941       | 951  | 962  | 972  | 982  | 993        | *003 |       |     |
| 417 | 62   | 014 | 024 | 034 | 045       | 055  | 066  | 076  | 086  | 097        | 107  |       |     |
| 418 |      | 118 | 128 | 138 | 149       | 159  | 170  | 180  | 190  | 201        | 211  |       |     |
| 419 |      | 221 | 232 | 242 | 252       | 263  | 273  | 284  | 294  | 304        | 315  |       |     |
| 420 |      | 325 | 335 | 346 | 356       | 366  | 377  | 387  | 397  | 408        | 418  | 10    |     |
| 421 |      | 428 | 439 | 449 | 459       | 469  | 480  | 490  | 500  | 511        | 521  | 1     |     |
| 422 |      | 531 | 542 | 552 | 562       | 572  | 583  | 593  | 603  | 613        | 624  | 2     |     |
| 423 |      | 634 | 644 | 655 | 665       | 675  | 685  | 696  | 706  | 716        | 726  | 3     |     |
| 424 |      | 737 | 747 | 757 | 767       | 778  | 788  | 798  | 808  | 818        | 829  | 4     |     |
| 425 |      | 839 | 849 | 859 | 870       | 880  | 890  | 900  | 910  | 921        | 931  | 5     |     |
| 426 |      | 941 | 951 | 961 | 972       | 982  | 992  | *002 | *012 | *022       | *033 | 6     |     |
| 427 | 63   | 043 | 053 | 063 | 073       | 083  | 094  | 104  | 114  | 124        | 134  | 7     |     |
| 428 |      | 144 | 155 | 165 | 175       | 185  | 195  | 205  | 215  | 225        | 236  | 8     |     |
| 429 |      | 246 | 256 | 266 | 276       | 286  | 296  | 306  | 317  | 327        | 337  | 9     |     |
| 430 |      | 347 | 357 | 367 | 377       | 387  | 397  | 407  | 417  | 428        | 438  |       |     |
| 431 |      | 448 | 458 | 468 | 478       | 488  | 498  | 508  | 518  | 528        | 538  |       |     |
| 432 |      | 548 | 558 | 568 | 579       | 589  | 599  | 609  | 619  | 629        | 639  |       |     |
| 433 |      | 649 | 659 | 669 | 679       | 689  | 699  | 709  | 719  | 729        | 739  |       |     |
| 434 |      | 749 | 759 | 769 | 779       | 789  | 799  | 809  | 819  | 829        | 839  |       |     |
| 435 |      | 849 | 859 | 869 | 879       | 889  | 899  | 909  | 919  | 929        | 939  |       |     |
| 436 |      | 949 | 959 | 969 | 979       | 988  | 998  | *008 | *018 | *028       | *038 |       |     |
| 437 | 64   | 048 | 058 | 068 | 078       | 088  | 098  | 108  | 118  | 128        | 137  | 9     |     |
| 438 |      | 147 | 157 | 167 | 177       | 187  | 197  | 207  | 217  | 227        | 237  | 1     |     |
| 439 |      | 246 | 256 | 266 | 276       | 286  | 296  | 306  | 316  | 326        | 335  | 2     |     |
| 440 |      | 345 | 355 | 365 | 375       | 385  | 395  | 404  | 414  | 424        | 434  | 3     |     |
| 441 |      | 444 | 454 | 464 | 473       | 483  | 493  | 503  | 513  | 523        | 532  | 4     |     |
| 442 |      | 542 | 552 | 562 | 572       | 582  | 591  | 601  | 611  | 621        | 631  | 5     |     |
| 443 |      | 640 | 650 | 660 | 670       | 680  | 689  | 699  | 709  | 719        | 729  | 6     |     |
| 444 |      | 738 | 748 | 758 | 768       | 777  | 787  | 797  | 807  | 816        | 826  | 7     |     |
| 445 |      | 836 | 846 | 856 | 865       | 875  | 885  | 895  | 904  | 914        | 924  | 8     |     |
| 446 |      | 933 | 943 | 953 | 963       | 972  | 982  | 992  | *002 | *011       | *021 | 9     |     |
| 447 | 65   | 031 | 040 | 050 | 060       | 070  | 079  | 089  | 099  | 108        | 118  |       |     |
| 448 |      | 128 | 137 | 147 | 157       | 167  | 176  | 186  | 196  | 205        | 215  |       |     |
| 449 |      | 225 | 234 | 244 | 254       | 263  | 273  | 283  | 292  | 302        | 312  |       |     |
| 450 |      | 321 | 331 | 341 | 350       | 360  | 369  | 379  | 389  | 398        | 408  |       |     |
| N.  | L.   | 0   | 1   | 2   | 3         | 4    | 5    | 6    | 7    | 8          | 9    | P. P. |     |
|     | S.   | T.  |     |     |           |      | S.   | T.   |      |            |      | S.    | T.  |
| 4'  | 6.46 | 373 | 373 | 0°  | 6' = 360" | 4.68 | 557  | 558  | 1°   | 9' = 4140" | 4.68 | 555   | 563 |
| 5   |      | 373 | 373 | 0°  | 7 = 420   |      | 557  | 558  | 1    | 10 = 4200  |      | 554   | 563 |
| 40  |      | 372 | 375 | 0°  | 8 = 480   |      | 557  | 558  | 1    | 11 = 4260  |      | 554   | 564 |
| 42  |      | 372 | 375 | 1   | 6 = 3960  |      | 555  | 563  | 1    | 12 = 4320  |      | 554   | 564 |
| 43  |      | 371 | 375 | 1   | 7 = 4020  |      | 555  | 563  | 1    | 13 = 4380  |      | 554   | 564 |
| 44  |      | 371 | 375 | 1   | 8 = 4080  |      | 555  | 563  | 1    | 14 = 4440  |      | 554   | 564 |
| 45  |      | 371 | 375 | 1   | 9 = 4140  |      | 555  | 563  | 1    | 15 = 4500  |      | 554   | 564 |

| N.  | L.   | 0     | 1     | 2    | 3         | 4      | 5      | 6    | 7    | 8           | 9     | P. P. |     |
|-----|------|-------|-------|------|-----------|--------|--------|------|------|-------------|-------|-------|-----|
| 450 | 65   | 321   | 331   | 341  | 350       | 360    | 369    | 379  | 389  | 398         | 408   |       |     |
| 451 |      | 418   | 427   | 437  | 447       | 456    | 466    | 475  | 485  | 495         | 504   |       |     |
| 452 |      | 514   | 523   | 533  | 543       | 552    | 562    | 571  | 581  | 591         | 600   |       |     |
| 453 |      | 610   | 619   | 629  | 639       | 648    | 658    | 667  | 677  | 686         | 696   |       |     |
| 454 |      | 706   | 715   | 725  | 734       | 744    | 753    | 763  | 772  | 782         | 792   |       |     |
| 455 |      | 801   | 811   | 820  | 830       | 839    | 849    | 858  | 868  | 877         | 887   |       |     |
| 456 |      | 896   | 906   | 916  | 925       | 935    | 944    | 954  | 963  | 973         | 982   | 10    |     |
| 457 |      | 992   | *001  | *011 | *020      | *030   | *039   | *049 | *058 | *068        | *077  | 1     |     |
| 458 | 66   | 087   | 096   | 106  | 115       | 124    | 134    | 143  | 153  | 162         | 172   | 2     |     |
| 459 |      | 181   | 191   | 200  | 210       | 219    | 229    | 238  | 247  | 257         | 266   | 3     |     |
| 460 |      | 276   | 285   | 295  | 304       | 314    | 323    | 332  | 342  | 351         | 361   | 4     |     |
| 461 |      | 370   | 380   | 389  | 398       | 408    | 417    | 427  | 436  | 445         | 455   | 5     |     |
| 462 |      | 464   | 474   | 483  | 492       | 502    | 511    | 521  | 530  | 539         | 549   | 6     |     |
| 463 |      | 558   | 567   | 577  | 586       | 596    | 605    | 614  | 624  | 633         | 642   | 7     |     |
| 464 |      | 652   | 661   | 671  | 680       | 689    | 699    | 708  | 717  | 727         | 736   | 8     |     |
| 465 |      | 745   | 755   | 764  | 773       | 783    | 792    | 801  | 811  | 820         | 829   | 9     |     |
| 466 |      | 839   | 848   | 857  | 867       | 876    | 885    | 894  | 904  | 913         | 922   |       |     |
| 467 |      | 932   | 941   | 950  | 960       | 969    | 978    | 987  | 997  | *006        | *015  |       |     |
| 468 | 67   | 025   | 034   | 043  | 052       | 062    | 071    | 080  | 089  | 099         | 108   |       |     |
| 469 |      | 117   | 127   | 136  | 145       | 154    | 164    | 173  | 182  | 191         | 201   |       |     |
| 470 |      | 210   | 219   | 228  | 237       | 247    | 256    | 265  | 274  | 284         | 293   |       |     |
| 471 |      | 302   | 311   | 321  | 330       | 339    | 348    | 357  | 367  | 376         | 385   | 9     |     |
| 472 |      | 394   | 403   | 413  | 422       | 431    | 440    | 449  | 459  | 468         | 477   | 1     |     |
| 473 |      | 486   | 495   | 504  | 514       | 523    | 532    | 541  | 550  | 560         | 569   | 2     |     |
| 474 |      | 578   | 587   | 596  | 605       | 614    | 624    | 633  | 642  | 651         | 660   | 3     |     |
| 475 |      | 669   | 679   | 688  | 697       | 706    | 715    | 724  | 733  | 742         | 752   | 4     |     |
| 476 |      | 761   | 770   | 779  | 788       | 797    | 806    | 815  | 825  | 834         | 843   | 5     |     |
| 477 |      | 852   | 861   | 870  | 879       | 888    | 897    | 906  | 916  | 925         | 934   | 6     |     |
| 478 |      | 943   | 952   | 961  | 970       | 979    | 988    | 997  | *006 | *015        | *024  | 7     |     |
| 479 | 68   | 034   | 043   | 052  | 061       | 070    | 079    | 088  | 097  | 106         | 115   | 8     |     |
| 480 |      | 124   | 133   | 142  | 151       | 160    | 169    | 178  | 187  | 196         | 205   |       |     |
| 481 |      | 215   | 224   | 233  | 242       | 251    | 260    | 269  | 278  | 287         | 296   |       |     |
| 482 |      | 305   | 314   | 323  | 332       | 341    | 350    | 359  | 368  | 377         | 386   |       |     |
| 483 |      | 395   | 404   | 413  | 422       | 431    | 440    | 449  | 458  | 467         | 476   |       |     |
| 484 |      | 485   | 494   | 502  | 511       | 520    | 529    | 538  | 547  | 556         | 565   |       |     |
| 485 |      | 574   | 583   | 592  | 601       | 610    | 619    | 628  | 637  | 646         | 655   |       |     |
| 486 |      | 664   | 673   | 681  | 690       | 699    | 708    | 717  | 726  | 735         | 744   |       |     |
| 487 |      | 753   | 762   | 771  | 780       | 789    | 797    | 806  | 815  | 824         | 833   | 8     |     |
| 488 |      | 842   | 851   | 860  | 869       | 878    | 886    | 895  | 904  | 913         | 922   | 1     |     |
| 489 |      | 931   | 940   | 949  | 958       | 966    | 975    | 984  | 993  | *002        | *011  | 2     |     |
| 490 | 69   | 020   | 028   | 037  | 046       | 055    | 064    | 073  | 082  | 090         | 099   | 3     |     |
| 491 |      | 108   | 117   | 126  | 135       | 144    | 152    | 161  | 170  | 179         | 188   | 4     |     |
| 492 |      | 197   | 205   | 214  | 223       | 232    | 241    | 249  | 258  | 267         | 276   | 5     |     |
| 493 |      | 285   | 294   | 302  | 311       | 320    | 329    | 338  | 346  | 355         | 364   | 6     |     |
| 494 |      | 373   | 381   | 390  | 399       | 408    | 417    | 425  | 434  | 443         | 452   | 7     |     |
| 495 |      | 461   | 469   | 478  | 487       | 496    | 504    | 513  | 522  | 531         | 539   | 8     |     |
| 496 |      | 548   | 557   | 566  | 574       | 583    | 592    | 601  | 609  | 618         | 627   | 9     |     |
| 497 |      | 636   | 644   | 653  | 662       | 671    | 679    | 688  | 697  | 705         | 714   |       |     |
| 498 |      | 723   | 732   | 740  | 749       | 758    | 767    | 775  | 784  | 793         | 801   | *     |     |
| 499 |      | 810   | 819   | 827  | 836       | 845    | 854    | 862  | 871  | 880         | 888   |       |     |
| 500 |      | 897   | 906   | 914  | 923       | 932    | 940    | 949  | 958  | 966         | 975   |       |     |
| N.  | L.   | 0     | 1     | 2    | 3         | 4      | 5      | 6    | 7    | 8           | 9     | P. P. |     |
|     |      | S. I' | T. I' |      |           | S. II' | T. II' |      |      | S. I'       | T. I' |       |     |
| 4'  | 6.46 | 373   | 373   | 0°   | 7' = 420" | 4.68   | 557    | 558  | 1°   | 18' = 4680" | 4.68  | 554   | 565 |
| 5   |      | 373   | 373   | 0    | 8 = 480   |        | 557    | 558  | 1    | 19 = 4740   |       | 554   | 565 |
| 45  |      | 371   | 375   | 0    | 9 = 540   |        | 557    | 558  | 1    | 20 = 4800   |       | 554   | 565 |
| 48  |      | 371   | 375   | 1    | 15 = 4500 |        | 554    | 564  | 1    | 21 = 4860   |       | 553   | 566 |
| 49  |      | 371   | 376   | 1    | 16 = 4560 |        | 554    | 565  | 1    | 22 = 4920   |       | 553   | 566 |
| 50  |      | 371   | 376   | 1    | 17 = 4620 |        | 554    | 565  | 1    | 23 = 4980   |       | 553   | 566 |
|     |      |       |       | 1    | 18 = 4680 |        | 554    | 565  | 1    | 24 = 5040   |       | 553   | 566 |



| N.  | L.   | 0       | 1                  | 2    | 3    | 4    | 5       | 6                    | 7    | 8    | 9    | P. P.   |
|-----|------|---------|--------------------|------|------|------|---------|----------------------|------|------|------|---------|
| 500 | 69   | 897     | 906                | 914  | 923  | 932  | 940     | 949                  | 958  | 966  | 975  |         |
| 501 |      | 984     | 992                | *001 | *010 | *018 | *027    | *036                 | *044 | *053 | *062 |         |
| 502 | 70   | 070     | 079                | 088  | 096  | 105  | 114     | 122                  | 131  | 140  | 148  |         |
| 503 |      | 157     | 165                | 174  | 183  | 191  | 200     | 209                  | 217  | 226  | 234  |         |
| 504 |      | 243     | 252                | 260  | 269  | 278  | 286     | 295                  | 303  | 312  | 321  |         |
| 505 |      | 329     | 338                | 346  | 355  | 364  | 372     | 381                  | 389  | 398  | 406  |         |
| 506 |      | 415     | 424                | 432  | 441  | 449  | 458     | 467                  | 475  | 484  | 492  |         |
| 507 |      | 501     | 509                | 518  | 526  | 535  | 544     | 552                  | 561  | 569  | 578  |         |
| 508 |      | 586     | 595                | 603  | 612  | 621  | 629     | 638                  | 646  | 655  | 663  |         |
| 509 |      | 672     | 680                | 689  | 697  | 706  | 714     | 723                  | 731  | 740  | 749  |         |
| 510 |      | 757     | 766                | 774  | 783  | 791  | 800     | 808                  | 817  | 825  | 834  |         |
| 511 |      | 842     | 851                | 859  | 868  | 876  | 885     | 893                  | 902  | 910  | 919  |         |
| 512 |      | 927     | 935                | 944  | 952  | 961  | 969     | 978                  | 986  | 995  | *003 |         |
| 513 | 71   | 012     | 020                | 029  | 037  | 046  | 054     | 063                  | 071  | 079  | 088  |         |
| 514 |      | 096     | 105                | 113  | 122  | 130  | 139     | 147                  | 155  | 164  | 172  |         |
| 515 |      | 181     | 189                | 198  | 206  | 214  | 223     | 231                  | 240  | 248  | 257  |         |
| 516 |      | 265     | 273                | 282  | 290  | 299  | 307     | 315                  | 324  | 332  | 341  |         |
| 517 |      | 349     | 357                | 366  | 374  | 383  | 391     | 399                  | 408  | 416  | 425  |         |
| 518 |      | 433     | 441                | 450  | 458  | 466  | 475     | 483                  | 492  | 500  | 508  |         |
| 519 |      | 517     | 525                | 533  | 542  | 550  | 559     | 567                  | 575  | 584  | 592  |         |
| 520 |      | 600     | 609                | 617  | 625  | 634  | 642     | 650                  | 659  | 667  | 675  |         |
| 521 |      | 684     | 692                | 700  | 709  | 717  | 725     | 734                  | 742  | 750  | 759  |         |
| 522 |      | 767     | 775                | 784  | 792  | 800  | 809     | 817                  | 825  | 834  | 842  |         |
| 523 |      | 850     | 858                | 867  | 875  | 883  | 892     | 900                  | 908  | 917  | 925  |         |
| 524 |      | 933     | 941                | 950  | 958  | 966  | 975     | 983                  | 991  | 999  | *008 |         |
| 525 | 72   | 016     | 024                | 032  | 041  | 049  | 057     | 066                  | 074  | 082  | 090  |         |
| 526 |      | 099     | 107                | 115  | 123  | 132  | 140     | 148                  | 156  | 165  | 173  |         |
| 527 |      | 181     | 189                | 198  | 206  | 214  | 222     | 230                  | 239  | 247  | 255  |         |
| 528 |      | 263     | 272                | 280  | 288  | 296  | 304     | 313                  | 321  | 329  | 337  |         |
| 529 |      | 346     | 354                | 362  | 370  | 378  | 387     | 395                  | 403  | 411  | 419  |         |
| 530 |      | 428     | 436                | 444  | 452  | 460  | 469     | 477                  | 485  | 493  | 501  |         |
| 531 |      | 509     | 518                | 526  | 534  | 542  | 550     | 558                  | 567  | 575  | 583  |         |
| 532 |      | 591     | 599                | 607  | 616  | 624  | 632     | 640                  | 648  | 656  | 665  |         |
| 533 |      | 673     | 681                | 689  | 697  | 705  | 713     | 722                  | 730  | 738  | 746  |         |
| 534 |      | 754     | 762                | 770  | 779  | 787  | 795     | 803                  | 811  | 819  | 827  |         |
| 535 |      | 835     | 843                | 852  | 860  | 868  | 876     | 884                  | 892  | 900  | 908  |         |
| 536 |      | 916     | 925                | 933  | 941  | 949  | 957     | 965                  | 973  | 981  | 989  |         |
| 537 |      | 997     | *006               | *014 | *022 | *030 | *038    | *046                 | *054 | *062 | *070 |         |
| 538 | 73   | 008     | 016                | 024  | 032  | 040  | 048     | 056                  | 064  | 072  | 080  |         |
| 539 |      | 159     | 167                | 175  | 183  | 191  | 199     | 207                  | 215  | 223  | 231  |         |
| 540 |      | 239     | 247                | 255  | 263  | 272  | 280     | 288                  | 296  | 304  | 312  |         |
| 541 |      | 320     | 328                | 336  | 344  | 352  | 360     | 368                  | 376  | 384  | 392  |         |
| 542 |      | 400     | 408                | 416  | 424  | 432  | 440     | 448                  | 456  | 464  | 472  |         |
| 543 |      | 480     | 488                | 496  | 504  | 512  | 520     | 528                  | 536  | 544  | 552  |         |
| 544 |      | 560     | 568                | 576  | 584  | 592  | 600     | 608                  | 616  | 624  | 632  |         |
| 545 |      | 640     | 648                | 656  | 664  | 672  | 679     | 687                  | 695  | 703  | 711  |         |
| 546 |      | 719     | 727                | 735  | 743  | 751  | 759     | 767                  | 775  | 783  | 791  |         |
| 547 |      | 799     | 807                | 815  | 823  | 830  | 838     | 846                  | 854  | 862  | 870  |         |
| 548 |      | 878     | 886                | 894  | 902  | 910  | 918     | 926                  | 933  | 941  | 949  |         |
| 549 |      | 957     | 965                | 973  | 981  | 989  | 997     | *005                 | *013 | *020 | *028 |         |
| 550 | 74   | 036     | 044                | 052  | 060  | 068  | 076     | 084                  | 092  | 099  | 107  |         |
| N.  | L.   | 0       | 1                  | 2    | 3    | 4    | 5       | 6                    | 7    | 8    | 9    | P. P.   |
|     |      | S.' T.' |                    |      |      |      | S.' T.' |                      |      |      |      | S.' T.' |
| 5'  | 6.46 | 373 373 | 0° 8' = 480'' 4.68 |      |      |      | 557 558 | 1° 26' = 5160'' 4.68 |      |      |      | 553 567 |
| 6   |      | 373 373 | 0 9 = 540          |      |      |      | 557 558 | 1 27 = 5220          |      |      |      | 553 567 |
| 50  | 37I  | 376     | 0 10 = 600         |      |      |      | 557 558 | 1 28 = 5280          |      |      |      | 553 567 |
| 55  | 37I  | 376     | 1 23 = 4980        |      |      |      | 553 566 | 1 29 = 5340          |      |      |      | 553 567 |
|     |      |         | 1 24 = 5040        |      |      |      | 553 566 | 1 30 = 5400          |      |      |      | 553 567 |
|     |      |         | 1 25 = 5100        |      |      |      | 553 566 | 1 31 = 5460          |      |      |      | 552 568 |
|     |      |         | 1 26 = 5160        |      |      |      | 553 567 | 1 32 = 5520          |      |      |      | 552 568 |

| N.  | L.   | 0   | 1   | 2   | 3   | 4    | 5            | 6    | 7    | 8    | 9    | P. P.          |      |     |     |
|-----|------|-----|-----|-----|-----|------|--------------|------|------|------|------|----------------|------|-----|-----|
| 550 | 74   | 036 | 044 | 052 | 060 | 068  | 076          | 084  | 092  | 099  | 107  |                |      |     |     |
| 551 |      | 115 | 123 | 131 | 139 | 147  | 155          | 162  | 170  | 178  | 186  |                |      |     |     |
| 552 |      | 194 | 202 | 210 | 218 | 225  | 233          | 241  | 249  | 257  | 265  |                |      |     |     |
| 553 |      | 273 | 280 | 288 | 296 | 304  | 312          | 320  | 327  | 335  | 343  |                |      |     |     |
| 554 |      | 351 | 359 | 367 | 374 | 382  | 390          | 398  | 406  | 414  | 421  |                |      |     |     |
| 555 |      | 429 | 437 | 445 | 453 | 461  | 468          | 476  | 484  | 492  | 500  |                |      |     |     |
| 556 |      | 507 | 515 | 523 | 531 | 539  | 547          | 554  | 562  | 570  | 578  |                |      |     |     |
| 557 |      | 586 | 593 | 601 | 609 | 617  | 624          | 632  | 640  | 648  | 656  |                |      |     |     |
| 558 |      | 663 | 671 | 679 | 687 | 695  | 702          | 710  | 718  | 726  | 733  |                |      |     |     |
| 559 |      | 741 | 749 | 757 | 764 | 772  | 780          | 788  | 796  | 803  | 811  |                |      |     |     |
| 560 |      | 819 | 827 | 834 | 842 | 850  | 858          | 865  | 873  | 881  | 889  |                |      |     |     |
| 561 |      | 896 | 904 | 912 | 920 | 927  | 935          | 943  | 950  | 958  | 966  |                |      |     |     |
| 562 |      | 974 | 981 | 989 | 997 | *005 | *012         | *020 | *028 | *035 | *043 |                |      |     |     |
| 563 | 75   | 051 | 059 | 066 | 074 | 082  | 089          | 097  | 105  | 113  | 120  |                |      |     |     |
| 564 |      | 128 | 136 | 143 | 151 | 159  | 166          | 174  | 182  | 189  | 197  |                |      |     |     |
| 565 |      | 205 | 213 | 220 | 228 | 236  | 243          | 251  | 259  | 266  | 274  |                |      |     |     |
| 566 |      | 282 | 289 | 297 | 305 | 312  | 320          | 328  | 335  | 343  | 351  |                |      |     |     |
| 567 |      | 358 | 366 | 374 | 381 | 389  | 397          | 404  | 412  | 420  | 427  |                |      |     |     |
| 568 |      | 435 | 442 | 450 | 458 | 465  | 473          | 481  | 488  | 496  | 504  |                |      |     |     |
| 569 |      | 511 | 519 | 526 | 534 | 542  | 549          | 557  | 565  | 572  | 580  |                |      |     |     |
| 570 |      | 587 | 595 | 603 | 610 | 618  | 626          | 633  | 641  | 648  | 656  |                |      |     |     |
| 571 |      | 664 | 671 | 679 | 686 | 694  | 702          | 709  | 717  | 724  | 732  |                |      |     |     |
| 572 |      | 740 | 747 | 755 | 762 | 770  | 778          | 785  | 793  | 800  | 808  |                |      |     |     |
| 573 |      | 815 | 823 | 831 | 838 | 846  | 853          | 861  | 868  | 876  | 884  |                |      |     |     |
| 574 |      | 891 | 899 | 906 | 914 | 921  | 929          | 937  | 944  | 952  | 959  |                |      |     |     |
| 575 |      | 967 | 974 | 982 | 989 | 997  | *005         | *012 | *020 | *027 | *035 |                |      |     |     |
| 576 | 76   | 042 | 050 | 057 | 065 | 072  | 080          | 087  | 095  | 103  | 110  |                |      |     |     |
| 577 |      | 118 | 125 | 133 | 140 | 148  | 155          | 163  | 170  | 178  | 185  |                |      |     |     |
| 578 |      | 193 | 200 | 208 | 215 | 223  | 230          | 238  | 245  | 253  | 260  |                |      |     |     |
| 579 |      | 268 | 275 | 283 | 290 | 298  | 305          | 313  | 320  | 328  | 335  |                |      |     |     |
| 580 |      | 343 | 350 | 358 | 365 | 373  | 380          | 388  | 395  | 403  | 410  |                |      |     |     |
| 581 |      | 418 | 425 | 433 | 440 | 448  | 455          | 462  | 470  | 477  | 485  |                |      |     |     |
| 582 |      | 492 | 500 | 507 | 515 | 522  | 530          | 537  | 545  | 552  | 559  |                |      |     |     |
| 583 |      | 567 | 574 | 582 | 589 | 597  | 604          | 612  | 619  | 626  | 634  |                |      |     |     |
| 584 |      | 641 | 649 | 656 | 664 | 671  | 678          | 686  | 693  | 701  | 708  |                |      |     |     |
| 585 |      | 716 | 723 | 730 | 738 | 745  | 753          | 760  | 768  | 775  | 782  |                |      |     |     |
| 586 |      | 790 | 797 | 805 | 812 | 819  | 827          | 834  | 842  | 849  | 856  |                |      |     |     |
| 587 |      | 864 | 871 | 879 | 886 | 893  | 901          | 908  | 916  | 923  | 930  |                |      |     |     |
| 588 |      | 938 | 945 | 953 | 960 | 967  | 975          | 982  | 989  | 997  | *004 |                |      |     |     |
| 589 | 77   | 012 | 019 | 026 | 034 | 041  | 048          | 056  | 063  | 070  | 078  |                |      |     |     |
| 590 |      | 085 | 093 | 100 | 107 | 115  | 122          | 129  | 137  | 144  | 151  |                |      |     |     |
| 591 |      | 159 | 166 | 173 | 181 | 188  | 195          | 203  | 210  | 217  | 225  |                |      |     |     |
| 592 |      | 232 | 240 | 247 | 254 | 262  | 269          | 276  | 283  | 291  | 298  |                |      |     |     |
| 593 |      | 305 | 313 | 320 | 327 | 335  | 342          | 349  | 357  | 364  | 371  |                |      |     |     |
| 594 |      | 379 | 386 | 393 | 401 | 408  | 415          | 422  | 430  | 437  | 444  |                |      |     |     |
| 595 |      | 452 | 459 | 466 | 474 | 481  | 488          | 495  | 503  | 510  | 517  |                |      |     |     |
| 596 |      | 525 | 532 | 539 | 546 | 554  | 561          | 568  | 576  | 583  | 590  |                |      |     |     |
| 597 |      | 597 | 605 | 612 | 619 | 627  | 634          | 641  | 648  | 656  | 663  |                |      |     |     |
| 598 |      | 670 | 677 | 685 | 692 | 699  | 706          | 714  | 721  | 728  | 735  |                |      |     |     |
| 599 |      | 743 | 750 | 757 | 764 | 772  | 779          | 786  | 793  | 801  | 808  |                |      |     |     |
| 600 |      | 815 | 822 | 830 | 837 | 844  | 851          | 859  | 866  | 873  | 880  |                |      |     |     |
| N.  | L.   | 0   | 1   | 2   | 3   | 4    | 5            | 6    | 7    | 8    | 9    | P. P.          |      |     |     |
|     | S.   | T.  |     |     |     |      | S.           | T.   |      |      |      | S.             | T.   |     |     |
| 6'  | 6.46 | 373 | 373 |     |     |      | 0° 9' = 540" | 4.68 | 557  | 558  |      | 1° 35' = 5700" | 4.68 | 552 | 569 |
| 55  |      | 371 | 376 |     |     |      | 0 10 = 600   |      | 557  | 558  |      | 1 36 = 5760    |      | 552 | 569 |
| 56  |      | 371 | 376 |     |     |      | 1 31 = 5460  |      | 552  | 568  |      | 1 37 = 5820    |      | 552 | 569 |
| 57  |      | 371 | 377 |     |     |      | 1 32 = 5520  |      | 552  | 568  |      | 1 38 = 5880    |      | 552 | 569 |
| 58  |      | 371 | 377 |     |     |      | 1 33 = 5580  |      | 552  | 568  |      | 1 39 = 5940    |      | 551 | 569 |
| 59  |      | 370 | 377 |     |     |      | 1 34 = 5640  |      | 552  | 568  |      | 1 40 = 6000    |      | 551 | 570 |
| 60  |      | 370 | 377 |     |     |      | 1 35 = 5700  |      | 552  | 569  |      |                |      |     |     |

| N.  | L.    | 0     | 1   | 2   | 3           | 4    | 5      | 6      | 7    | 8            | 9    | P. P.  |        |
|-----|-------|-------|-----|-----|-------------|------|--------|--------|------|--------------|------|--------|--------|
| 600 | 77    | 815   | 822 | 830 | 837         | 844  | 851    | 859    | 866  | 873          | 880  |        |        |
| 601 |       | 887   | 895 | 902 | 909         | 916  | 924    | 931    | 938  | 945          | 952  |        |        |
| 602 |       | 960   | 967 | 974 | 981         | 988  | 996    | *003   | *010 | *017         | *025 |        |        |
| 603 | 78    | 032   | 039 | 046 | 053         | 061  | 068    | 075    | 082  | 089          | 097  |        |        |
| 604 |       | 104   | 111 | 118 | 125         | 132  | 140    | 147    | 154  | 161          | 168  |        |        |
| 605 |       | 176   | 183 | 190 | 197         | 204  | 211    | 219    | 226  | 233          | 240  |        |        |
| 606 |       | 247   | 254 | 262 | 269         | 276  | 283    | 290    | 297  | 305          | 312  | 8      |        |
| 607 |       | 319   | 326 | 333 | 340         | 347  | 355    | 362    | 369  | 376          | 383  | 1 0.8  |        |
| 608 |       | 390   | 398 | 405 | 412         | 419  | 426    | 433    | 440  | 447          | 455  | 2 1.6  |        |
| 609 |       | 462   | 469 | 476 | 483         | 490  | 497    | 504    | 512  | 519          | 526  | 3 2.4  |        |
| 610 |       | 533   | 540 | 547 | 554         | 561  | 569    | 576    | 583  | 590          | 597  | 4 3.2  |        |
| 611 |       | 604   | 611 | 618 | 625         | 633  | 640    | 647    | 654  | 661          | 668  | 5 4.0  |        |
| 612 |       | 675   | 682 | 689 | 696         | 704  | 711    | 718    | 725  | 732          | 739  | 6 4.8  |        |
| 613 |       | 746   | 753 | 760 | 767         | 774  | 781    | 789    | 796  | 803          | 810  | 7 5.6  |        |
| 614 |       | 817   | 824 | 831 | 838         | 845  | 852    | 859    | 866  | 873          | 880  | 8 6.4  |        |
| 615 |       | 888   | 895 | 902 | 909         | 916  | 923    | 930    | 937  | 944          | 951  | 9 7.2  |        |
| 616 |       | 958   | 965 | 972 | 979         | 986  | 993    | *000   | *007 | *014         | *021 |        |        |
| 617 | 79    | 029   | 036 | 043 | 050         | 057  | 064    | 071    | 078  | 085          | 092  |        |        |
| 618 |       | 099   | 106 | 113 | 120         | 127  | 134    | 141    | 148  | 155          | 162  |        |        |
| 619 |       | 169   | 176 | 183 | 190         | 197  | 204    | 211    | 218  | 225          | 232  |        |        |
| 620 |       | 239   | 246 | 253 | 260         | 267  | 274    | 281    | 288  | 295          | 302  | 7      |        |
| 621 |       | 309   | 316 | 323 | 330         | 337  | 344    | 351    | 358  | 365          | 372  | 1 0.7  |        |
| 622 |       | 379   | 386 | 393 | 400         | 407  | 414    | 421    | 428  | 435          | 442  | 2 1.4  |        |
| 623 |       | 449   | 456 | 463 | 470         | 477  | 484    | 491    | 498  | 505          | 511  | 3 2.1  |        |
| 624 |       | 518   | 525 | 532 | 539         | 546  | 553    | 560    | 567  | 574          | 581  | 4 2.8  |        |
| 625 |       | 588   | 595 | 602 | 609         | 616  | 623    | 630    | 637  | 644          | 650  | 5 3.5  |        |
| 626 |       | 657   | 664 | 671 | 678         | 685  | 692    | 699    | 706  | 713          | 720  | 6 4.2  |        |
| 627 |       | 727   | 734 | 741 | 748         | 754  | 761    | 768    | 775  | 782          | 789  | 7 4.9  |        |
| 628 |       | 796   | 803 | 810 | 817         | 824  | 831    | 837    | 844  | 851          | 858  | 8 5.6  |        |
| 629 |       | 865   | 872 | 879 | 886         | 893  | 900    | 906    | 913  | 920          | 927  | 9 6.3  |        |
| 630 |       | 934   | 941 | 948 | 955         | 962  | 969    | 975    | 982  | 989          | 996  |        |        |
| 631 | 80    | 003   | 010 | 017 | 024         | 030  | 037    | 044    | 051  | 058          | 065  |        |        |
| 632 |       | 072   | 079 | 085 | 092         | 099  | 106    | 113    | 120  | 127          | 134  |        |        |
| 633 |       | 140   | 147 | 154 | 161         | 168  | 175    | 182    | 188  | 195          | 202  |        |        |
| 634 |       | 209   | 216 | 223 | 229         | 236  | 243    | 250    | 257  | 264          | 271  |        |        |
| 635 |       | 277   | 284 | 291 | 298         | 305  | 312    | 318    | 325  | 332          | 339  |        |        |
| 636 |       | 346   | 353 | 359 | 366         | 373  | 380    | 387    | 393  | 400          | 407  | 6      |        |
| 637 |       | 414   | 421 | 428 | 434         | 441  | 448    | 455    | 462  | 468          | 475  | 1 0.6  |        |
| 638 |       | 482   | 489 | 496 | 502         | 509  | 516    | 523    | 530  | 536          | 543  | 2 1.2  |        |
| 639 |       | 550   | 557 | 564 | 570         | 577  | 584    | 591    | 598  | 604          | 611  | 3 1.8  |        |
| 640 |       | 618   | 625 | 632 | 638         | 645  | 652    | 659    | 665  | 672          | 679  | 4 2.4  |        |
| 641 |       | 686   | 693 | 699 | 706         | 713  | 720    | 726    | 733  | 740          | 747  | 5 3.0  |        |
| 642 |       | 754   | 760 | 767 | 774         | 781  | 787    | 794    | 801  | 808          | 814  | 6 3.6  |        |
| 643 |       | 821   | 828 | 835 | 841         | 848  | 855    | 862    | 868  | 875          | 882  | 7 4.2  |        |
| 644 |       | 889   | 895 | 902 | 909         | 916  | 922    | 929    | 936  | 943          | 949  | 8 4.8  |        |
| 645 |       | 956   | 963 | 969 | 976         | 983  | 990    | 996    | *003 | *010         | *017 | 9 5.4  |        |
| 646 | 81    | 023   | 030 | 037 | 043         | 050  | 057    | 064    | 070  | 077          | 084  |        |        |
| 647 |       | 090   | 097 | 104 | 111         | 117  | 124    | 131    | 137  | 144          | 151  |        |        |
| 648 |       | 158   | 164 | 171 | 178         | 184  | 191    | 198    | 204  | 211          | 218  |        |        |
| 649 |       | 224   | 231 | 238 | 245         | 251  | 258    | 265    | 271  | 278          | 285  |        |        |
| 650 |       | 291   | 298 | 305 | 311         | 318  | 325    | 331    | 338  | 345          | 351  |        |        |
| N.  | L.    | 0     | 1   | 2   | 3           | 4    | 5      | 6      | 7    | 8            | 9    | P. P.  |        |
|     | S. I' | T. I' |     |     |             |      | S. II' | T. II' |      |              |      | S. II' | T. II' |
| 6'  | 6.46  | 373   | 373 | 0°  | 10' = 600'' | 4.68 | 557    | 558    | 1°   | 44' = 6240'' | 4.68 | 551    | 571    |
| 7   |       | 373   | 373 | 0   | 11 = 660    |      | 557    | 558    | 1    | 45 = 6300    |      | 551    | 571    |
| 60  |       | 370   | 377 | I   | 40 = 6000   |      | 551    | 570    | I    | 46 = 6360    |      | 551    | 571    |
| 63  |       | 370   | 377 | I   | 41 = 6060   |      | 551    | 570    | I    | 47 = 6420    |      | 550    | 572    |
| 64  |       | 370   | 378 | I   | 42 = 6120   |      | 551    | 570    | I    | 48 = 6480    |      | 550    | 572    |
| 65  |       | 370   | 378 | I   | 43 = 6180   |      | 551    | 570    | I    | 49 = 6540    |      | 550    | 572    |
|     |       |       |     | I   | 44 = 6240   |      | 551    | 571    |      |              |      |        |        |

| N.  | L.   | 0   | 1    | 2        | 3    | 4    | 5    | 6    | 7        | 8     | 9    | P. P. |     |
|-----|------|-----|------|----------|------|------|------|------|----------|-------|------|-------|-----|
| 650 | 81   | 291 | 298  | 305      | 311  | 318  | 325  | 331  | 338      | 345   | 351  |       |     |
| 651 |      | 358 | 365  | 371      | 378  | 385  | 391  | 398  | 405      | 411   | 418  |       |     |
| 652 |      | 425 | 431  | 438      | 445  | 451  | 458  | 465  | 471      | 478   | 485  |       |     |
| 653 |      | 491 | 498  | 505      | 511  | 518  | 525  | 531  | 538      | 544   | 551  |       |     |
| 654 |      | 558 | 564  | 571      | 578  | 584  | 591  | 598  | 604      | 611   | 617  |       |     |
| 655 |      | 624 | 631  | 637      | 644  | 651  | 657  | 664  | 671      | 677   | 684  |       |     |
| 656 |      | 690 | 697  | 704      | 710  | 717  | 723  | 730  | 737      | 743   | 750  |       |     |
| 657 |      | 757 | 763  | 770      | 776  | 783  | 790  | 796  | 803      | 809   | 816  |       |     |
| 658 |      | 823 | 829  | 836      | 842  | 849  | 856  | 862  | 869      | 875   | 882  |       |     |
| 659 |      | 889 | 895  | 902      | 908  | 915  | 921  | 928  | 935      | 941   | 948  |       |     |
| 660 |      | 954 | 961  | 968      | 974  | 981  | 987  | 994  | *000     | *007  | *014 | 7     |     |
| 661 | 82   | 020 | 027  | 033      | 040  | 046  | 053  | 060  | 066      | 073   | 079  | 1 0.7 |     |
| 662 |      | 086 | 092  | 099      | 105  | 112  | 119  | 125  | 132      | 138   | 145  | 2 1.4 |     |
| 663 |      | 151 | 158  | 164      | 171  | 178  | 184  | 191  | 197      | 204   | 210  | 3 2.1 |     |
| 664 |      | 217 | 223  | 230      | 236  | 243  | 249  | 256  | 263      | 269   | 276  | 4 2.8 |     |
| 665 |      | 282 | 289  | 295      | 302  | 308  | 315  | 321  | 328      | 334   | 341  | 5 3.5 |     |
| 666 |      | 347 | 354  | 360      | 367  | 373  | 380  | 387  | 393      | 400   | 406  | 6 4.2 |     |
| 667 |      | 413 | 419  | 426      | 432  | 439  | 445  | 452  | 458      | 465   | 471  | 7 4.9 |     |
| 668 |      | 478 | 484  | 491      | 497  | 504  | 510  | 517  | 523      | 530   | 536  | 8 5.6 |     |
| 669 |      | 543 | 549  | 556      | 562  | 569  | 575  | 582  | 588      | 595   | 601  | 9 6.3 |     |
| 670 |      | 607 | 614  | 620      | 627  | 633  | 640  | 646  | 653      | 659   | 666  |       |     |
| 671 |      | 672 | 679  | 685      | 692  | 698  | 705  | 711  | 718      | 724   | 730  |       |     |
| 672 |      | 737 | 743  | 750      | 756  | 763  | 769  | 776  | 782      | 789   | 795  |       |     |
| 673 |      | 802 | 808  | 814      | 821  | 827  | 834  | 840  | 847      | 853   | 860  |       |     |
| 674 |      | 866 | 872  | 879      | 885  | 892  | 898  | 905  | 911      | 918   | 924  |       |     |
| 675 |      | 930 | 937  | 943      | 950  | 956  | 963  | 969  | 975      | 982   | 988  |       |     |
| 676 |      | 995 | *001 | *008     | *014 | *020 | *027 | *033 | *040     | *046  | *052 |       |     |
| 677 | 83   | 059 | 065  | 072      | 078  | 085  | 091  | 097  | 104      | 110   | 117  |       |     |
| 678 |      | 123 | 129  | 136      | 142  | 149  | 155  | 161  | 168      | 174   | 181  |       |     |
| 679 |      | 187 | 193  | 200      | 206  | 213  | 219  | 225  | 232      | 238   | 245  |       |     |
| 680 |      | 251 | 257  | 264      | 270  | 276  | 283  | 289  | 296      | 302   | 308  | 6     |     |
| 681 |      | 315 | 321  | 327      | 334  | 340  | 347  | 353  | 359      | 366   | 372  | 1 0.6 |     |
| 682 |      | 378 | 385  | 391      | 398  | 404  | 410  | 417  | 423      | 429   | 436  | 2 1.2 |     |
| 683 |      | 442 | 448  | 455      | 461  | 467  | 474  | 480  | 487      | 493   | 499  | 3 1.8 |     |
| 684 |      | 506 | 512  | 518      | 525  | 531  | 537  | 544  | 550      | 556   | 563  | 4 2.4 |     |
| 685 |      | 569 | 575  | 582      | 588  | 594  | 601  | 607  | 613      | 620   | 626  | 5 3.0 |     |
| 686 |      | 632 | 639  | 645      | 651  | 658  | 664  | 670  | 677      | 683   | 689  | 6 3.6 |     |
| 687 |      | 696 | 702  | 708      | 715  | 721  | 727  | 734  | 740      | 746   | 753  | 7 4.2 |     |
| 688 |      | 759 | 765  | 771      | 778  | 784  | 790  | 797  | 803      | 809   | 816  | 8 4.8 |     |
| 689 |      | 822 | 828  | 835      | 841  | 847  | 853  | 860  | 866      | 872   | 879  | 9 5.4 |     |
| 690 |      | 885 | 891  | 897      | 904  | 910  | 916  | 923  | 929      | 935   | 942  |       |     |
| 691 |      | 948 | 954  | 960      | 967  | 973  | 979  | 985  | 992      | 998   | *004 |       |     |
| 692 | 84   | 011 | 017  | 023      | 029  | 036  | 042  | 048  | 055      | 061   | 067  |       |     |
| 693 |      | 073 | 080  | 086      | 092  | 098  | 105  | 111  | 117      | 123   | 130  |       |     |
| 694 |      | 136 | 142  | 148      | 155  | 161  | 167  | 173  | 180      | 186   | 192  |       |     |
| 695 |      | 198 | 205  | 211      | 217  | 223  | 230  | 236  | 242      | 248   | 255  |       |     |
| 696 |      | 261 | 267  | 273      | 280  | 286  | 292  | 298  | 305      | 311   | 317  |       |     |
| 697 |      | 323 | 330  | 336      | 342  | 348  | 354  | 361  | 367      | 373   | 379  |       |     |
| 698 |      | 386 | 392  | 398      | 404  | 410  | 417  | 423  | 429      | 435   | 442  |       |     |
| 699 |      | 448 | 454  | 460      | 466  | 473  | 479  | 485  | 491      | 497   | 504  |       |     |
| 700 |      | 510 | 516  | 522      | 528  | 535  | 541  | 547  | 553      | 559   | 566  |       |     |
| N.  | L.   | 0   | 1    | 2        | 3    | 4    | 5    | 6    | 7        | 8     | 9    | P. P. |     |
|     | S.   | T.  |      |          |      |      | S.   | T.   |          |       |      | S.    | T.  |
| 6'  | 6.46 | 373 | 373  | 0° 10' = | 600" | 4.68 | 557  | 558  | 1° 51' = | 6660" | 4.68 | 550   | 573 |
| 7   |      | 373 | 373  | 0 11 =   | 660  |      | 557  | 558  | 1 52 =   | 6720  |      | 550   | 573 |
| 65  |      | 370 | 378  | 0 12 =   | 720  |      | 557  | 558  | 1 53 =   | 6780  |      | 550   | 573 |
| 69  |      | 370 | 378  | 1 48 =   | 6480 |      | 550  | 572  | 1 54 =   | 6840  |      | 550   | 573 |
| 70  |      | 370 | 379  | 1 49 =   | 6540 |      | 550  | 572  | 1 55 =   | 6900  |      | 549   | 574 |
|     |      |     |      | 1 50 =   | 6600 |      | 550  | 572  | 1 56 =   | 6960  |      | 549   | 574 |
|     |      |     |      | 1 51 =   | 6660 |      | 550  | 573  | 1 57 =   | 7020  |      | 549   | 574 |



| N.         | L. | 0   | 1   | 2   | 3    | 4    | 5    | 6    | 7    | 8    | 9    | P. P. |
|------------|----|-----|-----|-----|------|------|------|------|------|------|------|-------|
| <b>750</b> | 87 | 506 | 512 | 518 | 523  | 529  | 535  | 541  | 547  | 552  | 558  |       |
| 751        |    | 564 | 570 | 576 | 581  | 587  | 593  | 599  | 604  | 610  | 616  |       |
| 752        |    | 622 | 628 | 633 | 639  | 645  | 651  | 656  | 662  | 668  | 674  |       |
| 753        |    | 679 | 685 | 691 | 697  | 703  | 708  | 714  | 720  | 726  | 731  |       |
| 754        |    | 737 | 743 | 749 | 754  | 760  | 766  | 772  | 777  | 783  | 789  |       |
| 755        |    | 795 | 800 | 806 | 812  | 818  | 823  | 829  | 835  | 841  | 846  |       |
| 756        |    | 852 | 858 | 864 | 869  | 875  | 881  | 887  | 892  | 898  | 904  |       |
| 757        |    | 910 | 915 | 921 | 927  | 933  | 938  | 944  | 950  | 955  | 961  |       |
| 758        |    | 967 | 973 | 978 | 984  | 990  | 996  | *001 | *007 | *013 | *018 |       |
| 759        | 88 | 024 | 030 | 036 | 041  | 047  | 053  | 058  | 064  | 070  | 076  |       |
| <b>760</b> |    | 081 | 087 | 093 | 098  | 104  | 110  | 116  | 121  | 127  | 133  |       |
| 761        |    | 138 | 144 | 150 | 156  | 161  | 167  | 173  | 178  | 184  | 190  | 6     |
| 762        |    | 195 | 201 | 207 | 213  | 218  | 224  | 230  | 235  | 241  | 247  | 1 0.6 |
| 763        |    | 252 | 258 | 264 | 270  | 275  | 281  | 287  | 292  | 298  | 304  | 2 1.2 |
| 764        |    | 309 | 315 | 321 | 326  | 332  | 338  | 343  | 349  | 355  | 360  | 3 1.8 |
| 765        |    | 366 | 372 | 377 | 383  | 389  | 395  | 400  | 406  | 412  | 417  | 4 2.4 |
| 766        |    | 423 | 429 | 434 | 440  | 446  | 451  | 457  | 463  | 468  | 474  | 5 3.0 |
| 767        |    | 480 | 485 | 491 | 497  | 502  | 508  | 513  | 519  | 525  | 530  | 6 3.6 |
| 768        |    | 536 | 542 | 547 | 553  | 559  | 564  | 570  | 576  | 581  | 587  | 7 4.2 |
| 769        |    | 593 | 598 | 604 | 610  | 615  | 621  | 627  | 632  | 638  | 643  | 8 4.8 |
| <b>770</b> |    | 649 | 655 | 660 | 666  | 672  | 677  | 683  | 689  | 694  | 700  | 9 5.4 |
| 771        |    | 705 | 711 | 717 | 722  | 728  | 734  | 739  | 745  | 750  | 756  |       |
| 772        |    | 762 | 767 | 773 | 779  | 784  | 790  | 795  | 801  | 807  | 812  |       |
| 773        |    | 818 | 824 | 829 | 835  | 840  | 846  | 852  | 857  | 863  | 868  |       |
| 774        |    | 874 | 880 | 885 | 891  | 897  | 902  | 908  | 913  | 919  | 925  |       |
| 775        |    | 930 | 936 | 941 | 947  | 953  | 958  | 964  | 969  | 975  | 981  |       |
| 776        |    | 986 | 992 | 997 | *003 | *009 | *014 | *020 | *025 | *031 | *037 |       |
| 777        | 89 | 042 | 048 | 053 | 059  | 064  | 070  | 076  | 081  | 087  | 092  |       |
| 778        |    | 098 | 104 | 109 | 115  | 120  | 126  | 131  | 137  | 143  | 148  |       |
| 779        |    | 154 | 159 | 165 | 170  | 176  | 182  | 187  | 193  | 198  | 204  |       |
| <b>780</b> |    | 209 | 215 | 221 | 226  | 232  | 237  | 243  | 248  | 254  | 260  | 5     |
| 781        |    | 265 | 271 | 276 | 282  | 287  | 293  | 298  | 304  | 310  | 315  | 1 0.5 |
| 782        |    | 321 | 326 | 332 | 337  | 343  | 348  | 354  | 360  | 365  | 371  | 2 1.0 |
| 783        |    | 376 | 382 | 387 | 393  | 398  | 404  | 409  | 415  | 421  | 426  | 3 1.5 |
| 784        |    | 432 | 437 | 443 | 448  | 454  | 459  | 465  | 470  | 476  | 481  | 4 2.0 |
| 785        |    | 487 | 492 | 498 | 504  | 509  | 515  | 520  | 526  | 531  | 537  | 5 2.5 |
| 786        |    | 542 | 548 | 553 | 559  | 564  | 570  | 575  | 581  | 586  | 592  | 6 3.0 |
| 787        |    | 597 | 603 | 609 | 614  | 620  | 625  | 631  | 636  | 642  | 647  | 7 3.5 |
| 788        |    | 653 | 658 | 664 | 669  | 675  | 680  | 686  | 691  | 697  | 702  | 8 4.0 |
| 789        |    | 708 | 713 | 719 | 724  | 730  | 735  | 741  | 746  | 752  | 757  | 9 4.5 |
| <b>790</b> |    | 763 | 768 | 774 | 779  | 785  | 790  | 796  | 801  | 807  | 812  |       |
| 791        |    | 818 | 823 | 829 | 834  | 840  | 845  | 851  | 856  | 862  | 867  |       |
| 792        |    | 873 | 878 | 883 | 889  | 894  | 900  | 905  | 911  | 916  | 922  |       |
| 793        |    | 927 | 933 | 938 | 944  | 949  | 955  | 960  | 966  | 971  | 977  |       |
| 794        |    | 982 | 988 | 993 | 998  | *004 | *009 | *015 | *020 | *026 | *031 |       |
| 795        | 90 | 037 | 042 | 048 | 053  | 059  | 064  | 069  | 075  | 080  | 086  |       |
| 796        |    | 091 | 097 | 102 | 108  | 113  | 119  | 124  | 129  | 135  | 140  |       |
| 797        |    | 146 | 151 | 157 | 162  | 168  | 173  | 179  | 184  | 189  | 195  |       |
| 798        |    | 200 | 206 | 211 | 217  | 222  | 227  | 233  | 238  | 244  | 249  |       |
| 799        |    | 255 | 260 | 266 | 271  | 276  | 282  | 287  | 293  | 298  | 304  |       |
| <b>800</b> |    | 309 | 314 | 320 | 325  | 331  | 336  | 342  | 347  | 352  | 358  |       |

| N. | L.   | 0       | 1   | 2              | 3    | 4         | 5   | 6              | 7    | 8   | 9         | P. P. |
|----|------|---------|-----|----------------|------|-----------|-----|----------------|------|-----|-----------|-------|
|    |      | S.' T.' |     |                |      | S.'' T.'' |     |                |      |     | S.'' T.'' |       |
| 7' | 6.46 | 373     | 373 | 0° 12' = 720'' | 4.68 | 557       | 558 | 2° 8' = 7680'' | 4.68 | 547 | 578       |       |
| 8  |      | 373     | 373 | 0 13 = 780     |      | 557       | 558 | 2 9 = 7740     |      | 547 | 578       |       |
| 75 |      | 369     | 380 | 0 14 = 840     |      | 557       | 558 | 2 10 = 7800    |      | 547 | 578       |       |
| 80 |      | 369     | 380 | 2 5 = 7500     |      | 548       | 577 | 2 11 = 7860    |      | 547 | 579       |       |
|    |      |         |     | 2 6 = 7560     |      | 548       | 577 | 2 12 = 7920    |      | 547 | 579       |       |
|    |      |         |     | 2 7 = 7620     |      | 548       | 577 | 2 13 = 7980    |      | 547 | 579       |       |
|    |      |         |     | 2 8 = 7680     |      | 547       | 578 | 2 14 = 8040    |      | 546 | 579       |       |

| N.         | L.   | 0       | 1   | 2              | 3    | 4       | 5   | 6               | 7    | 8       | 9    | P. P.   |
|------------|------|---------|-----|----------------|------|---------|-----|-----------------|------|---------|------|---------|
| <b>800</b> | 90   | 309     | 314 | 320            | 325  | 331     | 336 | 342             | 347  | 352     | 358  |         |
| 801        |      | 363     | 369 | 374            | 380  | 385     | 390 | 396             | 401  | 407     | 412  |         |
| 802        |      | 417     | 423 | 428            | 434  | 439     | 445 | 450             | 455  | 461     | 466  |         |
| 803        |      | 472     | 477 | 482            | 488  | 493     | 499 | 504             | 509  | 515     | 520  |         |
| 804        |      | 526     | 531 | 536            | 542  | 547     | 553 | 558             | 563  | 569     | 574  |         |
| 805        |      | 580     | 585 | 590            | 596  | 601     | 607 | 612             | 617  | 623     | 628  |         |
| 806        |      | 634     | 639 | 644            | 650  | 655     | 660 | 666             | 671  | 677     | 682  |         |
| 807        |      | 687     | 693 | 698            | 703  | 709     | 714 | 720             | 725  | 730     | 736  |         |
| 808        |      | 741     | 747 | 752            | 757  | 763     | 768 | 773             | 779  | 784     | 789  |         |
| 809        |      | 795     | 800 | 806            | 811  | 816     | 822 | 827             | 832  | 838     | 843  |         |
| <b>810</b> |      | 849     | 854 | 859            | 865  | 870     | 875 | 881             | 886  | 891     | 897  |         |
| 811        |      | 902     | 907 | 913            | 918  | 924     | 929 | 934             | 940  | 945     | 950  |         |
| 812        |      | 956     | 961 | 966            | 972  | 977     | 982 | 988             | 993  | 998     | *004 | 1 0.6   |
| 813        | 91   | 009     | 014 | 020            | 025  | 030     | 036 | 041             | 046  | 052     | 057  | 2 1.2   |
| 814        |      | 062     | 068 | 073            | 078  | 084     | 089 | 094             | 100  | 105     | 110  | 3 1.8   |
| 815        |      | 116     | 121 | 126            | 132  | 137     | 142 | 148             | 153  | 158     | 164  | 4 2.4   |
| 816        |      | 169     | 174 | 180            | 185  | 190     | 196 | 201             | 206  | 212     | 217  | 5 3.0   |
| 817        |      | 222     | 228 | 233            | 238  | 243     | 249 | 254             | 259  | 265     | 270  | 6 3.6   |
| 818        |      | 275     | 281 | 286            | 291  | 297     | 302 | 307             | 312  | 318     | 323  | 7 4.2   |
| 819        |      | 328     | 334 | 339            | 344  | 350     | 355 | 360             | 365  | 371     | 376  | 8 4.8   |
| <b>820</b> |      | 381     | 387 | 392            | 397  | 403     | 408 | 413             | 418  | 424     | 429  | 9 5.4   |
| 821        |      | 434     | 440 | 445            | 450  | 455     | 461 | 466             | 471  | 477     | 482  |         |
| 822        |      | 487     | 492 | 498            | 503  | 508     | 514 | 519             | 524  | 529     | 535  |         |
| 823        |      | 540     | 545 | 551            | 556  | 561     | 566 | 572             | 577  | 582     | 587  |         |
| 824        |      | 593     | 598 | 603            | 609  | 614     | 619 | 624             | 630  | 635     | 640  |         |
| 825        |      | 645     | 651 | 656            | 661  | 666     | 672 | 677             | 682  | 687     | 693  |         |
| 826        |      | 698     | 703 | 709            | 714  | 719     | 724 | 730             | 735  | 740     | 745  |         |
| 827        |      | 751     | 756 | 761            | 766  | 772     | 777 | 782             | 787  | 793     | 798  |         |
| 828        |      | 803     | 808 | 814            | 819  | 824     | 829 | 834             | 840  | 845     | 850  |         |
| 829        |      | 855     | 861 | 866            | 871  | 876     | 882 | 887             | 892  | 897     | 903  |         |
| <b>830</b> |      | 908     | 913 | 918            | 924  | 929     | 934 | 939             | 944  | 950     | 955  |         |
| 831        |      | 960     | 965 | 971            | 976  | 981     | 986 | 991             | 997  | *002    | *007 | 1 0.5   |
| 832        | 92   | 012     | 018 | 023            | 028  | 033     | 038 | 044             | 049  | 054     | 059  | 2 1.0   |
| 833        |      | 065     | 070 | 075            | 080  | 085     | 091 | 096             | 101  | 106     | 111  | 3 1.5   |
| 834        |      | 117     | 122 | 127            | 132  | 137     | 143 | 148             | 153  | 158     | 163  | 4 2.0   |
| 835        |      | 169     | 174 | 179            | 184  | 189     | 195 | 200             | 205  | 210     | 215  | 5 2.5   |
| 836        |      | 221     | 226 | 231            | 236  | 241     | 247 | 252             | 257  | 262     | 267  | 6 3.0   |
| 837        |      | 273     | 278 | 283            | 288  | 293     | 298 | 304             | 309  | 314     | 319  | 7 3.5   |
| 838        |      | 324     | 330 | 335            | 340  | 345     | 350 | 355             | 361  | 366     | 371  | 8 4.0   |
| 839        |      | 376     | 381 | 387            | 392  | 397     | 402 | 407             | 412  | 418     | 423  | 9 4.5   |
| <b>840</b> |      | 428     | 433 | 438            | 443  | 449     | 454 | 459             | 464  | 469     | 474  |         |
| 841        |      | 480     | 485 | 490            | 495  | 500     | 505 | 511             | 516  | 521     | 526  |         |
| 842        |      | 531     | 536 | 542            | 547  | 552     | 557 | 562             | 567  | 572     | 578  |         |
| 843        |      | 583     | 588 | 593            | 598  | 603     | 609 | 614             | 619  | 624     | 629  |         |
| 844        |      | 634     | 639 | 645            | 650  | 655     | 660 | 665             | 670  | 675     | 681  |         |
| 845        |      | 686     | 691 | 696            | 701  | 706     | 711 | 716             | 722  | 727     | 732  |         |
| 846        |      | 737     | 742 | 747            | 752  | 758     | 763 | 768             | 773  | 778     | 783  |         |
| 847        |      | 788     | 793 | 799            | 804  | 809     | 814 | 819             | 824  | 829     | 834  |         |
| 848        |      | 840     | 845 | 850            | 855  | 860     | 865 | 870             | 875  | 881     | 886  |         |
| 849        |      | 891     | 896 | 901            | 906  | 911     | 916 | 921             | 927  | 932     | 937  |         |
| <b>850</b> |      | 942     | 947 | 952            | 957  | 962     | 967 | 973             | 978  | 983     | 988  |         |
| N.         | L.   | 0       | 1   | 2              | 3    | 4       | 5   | 6               | 7    | 8       | 9    | P. P.   |
|            |      | S.' T.' |     |                |      | S.' T.' |     |                 |      |         |      | S.' T.' |
| 8'         | 6.46 | 373 373 |     | 0° 13' = 780'' | 4.68 | 557 558 |     | 2° 16' = 8160'' | 4.68 | 546 580 |      |         |
| 9          |      | 373 373 |     | 0 14 = 840     |      | 557 558 |     | 2 17 = 8220     |      | 546 580 |      |         |
| 80         |      | 369 380 |     | 0 15 = 900     |      | 557 558 |     | 2 18 = 8280     |      | 546 581 |      |         |
| 81         |      | 369 381 |     | 2 13 = 7980    |      | 547 579 |     | 2 19 = 8340     |      | 546 581 |      |         |
| 82         |      | 368 381 |     | 2 14 = 8040    |      | 546 579 |     | 2 20 = 8400     |      | 545 582 |      |         |
| 83         |      | 368 381 |     | 2 15 = 8100    |      | 546 580 |     | 2 21 = 8460     |      | 545 582 |      |         |
| 85         |      | 368 381 |     | 2 16 = 8160    |      | 546 580 |     | 2 22 = 8520     |      | 545 582 |      |         |

| N.         | L.   | 0       | 1   | 2    | 3             | 4    | 5         | 6    | 7    | 8              | 9         | P. P.   |
|------------|------|---------|-----|------|---------------|------|-----------|------|------|----------------|-----------|---------|
| <b>850</b> | 92   | 942     | 947 | 952  | 957           | 962  | 967       | 973  | 978  | 983            | 988       |         |
| 851        |      | 993     | 998 | *003 | *008          | *013 | *018      | *024 | *029 | *034           | *039      |         |
| 852        | 93   | 044     | 049 | 054  | 059           | 064  | 069       | 075  | 080  | 085            | 090       |         |
| 853        |      | 095     | 100 | 105  | 110           | 115  | 120       | 125  | 131  | 136            | 141       |         |
| 854        |      | 146     | 151 | 156  | 161           | 166  | 171       | 176  | 181  | 186            | 192       |         |
| 855        |      | 197     | 202 | 207  | 212           | 217  | 222       | 227  | 232  | 237            | 242       |         |
| 856        |      | 247     | 252 | 258  | 263           | 268  | 273       | 278  | 283  | 288            | 293       |         |
| 857        |      | 298     | 303 | 308  | 313           | 318  | 323       | 328  | 334  | 339            | 344       |         |
| 858        |      | 349     | 354 | 359  | 364           | 369  | 374       | 379  | 384  | 389            | 394       |         |
| 859        |      | 399     | 404 | 409  | 414           | 420  | 425       | 430  | 435  | 440            | 445       |         |
| <b>860</b> |      | 450     | 455 | 460  | 465           | 470  | 475       | 480  | 485  | 490            | 495       |         |
| 861        |      | 500     | 505 | 510  | 515           | 520  | 526       | 531  | 536  | 541            | 546       |         |
| 862        |      | 551     | 556 | 561  | 566           | 571  | 576       | 581  | 586  | 591            | 596       |         |
| 863        |      | 601     | 606 | 611  | 616           | 621  | 626       | 631  | 636  | 641            | 646       |         |
| 864        |      | 651     | 656 | 661  | 666           | 671  | 676       | 682  | 687  | 692            | 697       |         |
| 865        |      | 702     | 707 | 712  | 717           | 722  | 727       | 732  | 737  | 742            | 747       |         |
| 866        |      | 752     | 757 | 762  | 767           | 772  | 777       | 782  | 787  | 792            | 797       |         |
| 867        |      | 802     | 807 | 812  | 817           | 822  | 827       | 832  | 837  | 842            | 847       |         |
| 868        |      | 852     | 857 | 862  | 867           | 872  | 877       | 882  | 887  | 892            | 897       |         |
| 869        |      | 902     | 907 | 912  | 917           | 922  | 927       | 932  | 937  | 942            | 947       |         |
| <b>870</b> |      | 952     | 957 | 962  | 967           | 972  | 977       | 982  | 987  | 992            | 997       |         |
| 871        | 94   | 002     | 007 | 012  | 017           | 022  | 027       | 032  | 037  | 042            | 047       |         |
| 872        |      | 052     | 057 | 062  | 067           | 072  | 077       | 082  | 086  | 091            | 096       |         |
| 873        |      | 101     | 106 | 111  | 116           | 121  | 126       | 131  | 136  | 141            | 146       |         |
| 874        |      | 151     | 156 | 161  | 166           | 171  | 176       | 181  | 186  | 191            | 196       |         |
| 875        |      | 201     | 206 | 211  | 216           | 221  | 226       | 231  | 236  | 240            | 245       |         |
| 876        |      | 250     | 255 | 260  | 265           | 270  | 275       | 280  | 285  | 290            | 295       |         |
| 877        |      | 300     | 305 | 310  | 315           | 320  | 325       | 330  | 335  | 340            | 345       |         |
| 878        |      | 349     | 354 | 359  | 364           | 369  | 374       | 379  | 384  | 389            | 394       |         |
| 879        |      | 399     | 404 | 409  | 414           | 419  | 424       | 429  | 433  | 438            | 443       |         |
| <b>880</b> |      | 448     | 453 | 458  | 463           | 468  | 473       | 478  | 483  | 488            | 493       |         |
| 881        |      | 498     | 503 | 507  | 512           | 517  | 522       | 527  | 532  | 537            | 542       |         |
| 882        |      | 547     | 552 | 557  | 562           | 567  | 571       | 576  | 581  | 586            | 591       |         |
| 883        |      | 596     | 601 | 606  | 611           | 616  | 621       | 626  | 630  | 635            | 640       |         |
| 884        |      | 645     | 650 | 655  | 660           | 665  | 670       | 675  | 680  | 685            | 689       |         |
| 885        |      | 694     | 699 | 704  | 709           | 714  | 719       | 724  | 729  | 734            | 738       |         |
| 886        |      | 743     | 748 | 753  | 758           | 763  | 768       | 773  | 778  | 783            | 787       |         |
| 887        |      | 792     | 797 | 802  | 807           | 812  | 817       | 822  | 827  | 832            | 836       |         |
| 888        |      | 841     | 846 | 851  | 856           | 861  | 866       | 871  | 876  | 880            | 885       |         |
| 889        |      | 890     | 895 | 900  | 905           | 910  | 915       | 919  | 924  | 929            | 934       |         |
| <b>890</b> |      | 939     | 944 | 949  | 954           | 959  | 963       | 968  | 973  | 978            | 983       |         |
| 891        |      | 988     | 993 | 998  | *002          | *007 | *012      | *017 | *022 | *027           | *032      |         |
| 892        | 95   | 036     | 041 | 046  | 051           | 056  | 061       | 066  | 071  | 075            | 080       |         |
| 893        |      | 085     | 090 | 095  | 100           | 105  | 109       | 114  | 119  | 124            | 129       |         |
| 894        |      | 134     | 139 | 143  | 148           | 153  | 158       | 163  | 168  | 173            | 177       |         |
| 895        |      | 182     | 187 | 192  | 197           | 202  | 207       | 211  | 216  | 221            | 226       |         |
| 896        |      | 231     | 236 | 240  | 245           | 250  | 255       | 260  | 265  | 270            | 274       |         |
| 897        |      | 279     | 284 | 289  | 294           | 299  | 303       | 308  | 313  | 318            | 323       |         |
| 898        |      | 328     | 332 | 337  | 342           | 347  | 352       | 357  | 361  | 366            | 371       |         |
| 899        |      | 376     | 381 | 386  | 390           | 395  | 400       | 405  | 410  | 415            | 419       |         |
| <b>900</b> |      | 424     | 429 | 434  | 439           | 444  | 448       | 453  | 458  | 463            | 468       |         |
| N.         | L.   | 0       | 1   | 2    | 3             | 4    | 5         | 6    | 7    | 8              | 9         | P. P.   |
|            |      | S.' T.' |     |      |               |      | S.'' T.'' |      |      |                | S.'' T.'' |         |
| 8'         | 6.45 | 373     | 373 |      | 0° 14' = 840" | 4.68 | 557       | 558  |      | 2° 25' = 8700" | 4.68      | 543 583 |
| 9          |      | 373     | 373 |      | 0 15 = 900    |      | 557       | 558  |      | 2 26 = 8760    |           | 544 584 |
| 85         |      | 368     | 381 |      | 2 21 = 8460   |      | 545       | 582  |      | 2 27 = 8820    |           | 544 584 |
| 86         |      | 368     | 382 |      | 2 22 = 8520   |      | 545       | 582  |      | 2 28 = 8880    |           | 544 584 |
| 89         |      | 368     | 382 |      | 2 23 = 8580   |      | 545       | 583  |      | 2 29 = 8940    |           | 544 585 |
| 90         |      | 368     | 383 |      | 2 24 = 8640   |      | 545       | 583  |      | 2 30 = 9000    |           | 544 585 |
|            |      |         |     |      | 2 25 = 8700   |      | 545       | 583  |      |                |           |         |



| N.         | L.   | 0       | 1    | 2             | 3    | 4    | 5       | 6    | 7              | 8    | 9    | P. P.   |
|------------|------|---------|------|---------------|------|------|---------|------|----------------|------|------|---------|
| <b>900</b> | 95   | 424     | 429  | 434           | 439  | 444  | 448     | 453  | 458            | 463  | 468  |         |
| 901        |      | 472     | 477  | 482           | 487  | 492  | 497     | 501  | 506            | 511  | 516  |         |
| 902        |      | 521     | 525  | 530           | 535  | 540  | 545     | 550  | 554            | 559  | 564  |         |
| 903        |      | 569     | 574  | 578           | 583  | 588  | 593     | 598  | 602            | 607  | 612  |         |
| 904        |      | 617     | 622  | 626           | 631  | 636  | 641     | 646  | 650            | 655  | 660  |         |
| 905        |      | 665     | 670  | 674           | 679  | 684  | 689     | 694  | 698            | 703  | 708  |         |
| 906        |      | 713     | 718  | 722           | 727  | 732  | 737     | 742  | 746            | 751  | 756  |         |
| 907        |      | 761     | 766  | 770           | 775  | 780  | 785     | 789  | 794            | 799  | 804  |         |
| 908        |      | 809     | 813  | 818           | 823  | 828  | 832     | 837  | 842            | 847  | 852  |         |
| 909        |      | 856     | 861  | 866           | 871  | 875  | 880     | 885  | 890            | 895  | 899  |         |
| <b>910</b> |      | 904     | 909  | 914           | 918  | 923  | 928     | 933  | 938            | 942  | 947  |         |
| 911        |      | 952     | 957  | 961           | 966  | 971  | 976     | 980  | 985            | 990  | 995  | 5       |
| 912        |      | 999     | *004 | *009          | *014 | *019 | *023    | *028 | *033           | *038 | *042 | 1 0.5   |
| 913        | 96   | 047     | 052  | 057           | 061  | 066  | 071     | 076  | 080            | 085  | 090  | 2 1.0   |
| 914        |      | 093     | 099  | 104           | 109  | 114  | 118     | 123  | 128            | 133  | 137  | 3 1.5   |
| 915        |      | 142     | 147  | 152           | 156  | 161  | 166     | 171  | 175            | 180  | 185  | 4 2.0   |
| 916        |      | 190     | 194  | 199           | 204  | 209  | 213     | 218  | 223            | 227  | 232  | 5 2.5   |
| 917        |      | 237     | 242  | 246           | 251  | 256  | 261     | 265  | 270            | 275  | 280  | 6 3.0   |
| 918        |      | 284     | 289  | 294           | 298  | 303  | 308     | 313  | 317            | 322  | 327  | 7 3.5   |
| 919        |      | 332     | 336  | 341           | 346  | 350  | 355     | 360  | 365            | 369  | 374  | 8 4.0   |
| <b>920</b> |      | 379     | 384  | 388           | 393  | 398  | 402     | 407  | 412            | 417  | 421  | 9 4.5   |
| 921        |      | 426     | 431  | 435           | 440  | 445  | 450     | 454  | 459            | 464  | 468  |         |
| 922        |      | 473     | 478  | 483           | 487  | 492  | 497     | 501  | 506            | 511  | 515  |         |
| 923        |      | 520     | 525  | 530           | 534  | 539  | 544     | 548  | 553            | 558  | 562  |         |
| 924        |      | 567     | 572  | 577           | 581  | 586  | 591     | 595  | 600            | 605  | 609  |         |
| 925        |      | 614     | 619  | 624           | 628  | 633  | 638     | 642  | 647            | 652  | 656  |         |
| 926        |      | 661     | 666  | 670           | 675  | 680  | 685     | 689  | 694            | 699  | 703  |         |
| 927        |      | 708     | 713  | 717           | 722  | 727  | 731     | 736  | 741            | 745  | 750  |         |
| 928        |      | 755     | 759  | 764           | 769  | 774  | 778     | 783  | 788            | 792  | 797  |         |
| 929        |      | 802     | 806  | 811           | 816  | 820  | 825     | 830  | 834            | 839  | 844  |         |
| <b>930</b> |      | 848     | 853  | 858           | 862  | 867  | 872     | 876  | 881            | 886  | 890  |         |
| 931        |      | 893     | 900  | 904           | 909  | 914  | 918     | 923  | 928            | 932  | 937  | 4       |
| 932        |      | 942     | 946  | 951           | 956  | 960  | 965     | 970  | 974            | 979  | 984  | 1 0.4   |
| 933        |      | 988     | 993  | 997           | *002 | *007 | *011    | *016 | *021           | *025 | *030 | 2 0.8   |
| 934        | 97   | 035     | 039  | 044           | 049  | 053  | 058     | 063  | 067            | 072  | 077  | 3 1.2   |
| 935        |      | 081     | 086  | 090           | 095  | 100  | 104     | 109  | 114            | 118  | 123  | 4 1.6   |
| 936        |      | 128     | 132  | 137           | 142  | 146  | 151     | 155  | 160            | 165  | 169  | 5 2.0   |
| 937        |      | 174     | 179  | 183           | 188  | 192  | 197     | 202  | 206            | 211  | 216  | 6 2.4   |
| 938        |      | 220     | 225  | 230           | 234  | 239  | 243     | 248  | 253            | 257  | 262  | 7 2.8   |
| 939        |      | 267     | 271  | 276           | 280  | 285  | 290     | 294  | 299            | 304  | 308  | 8 3.2   |
| <b>940</b> |      | 313     | 317  | 322           | 327  | 331  | 336     | 340  | 345            | 350  | 354  | 9 3.6   |
| 941        |      | 359     | 364  | 368           | 373  | 377  | 382     | 387  | 391            | 396  | 400  |         |
| 942        |      | 405     | 410  | 414           | 419  | 424  | 428     | 433  | 437            | 442  | 447  |         |
| 943        |      | 451     | 456  | 460           | 465  | 470  | 474     | 479  | 483            | 488  | 493  |         |
| 944        |      | 497     | 502  | 506           | 511  | 516  | 520     | 525  | 529            | 534  | 539  |         |
| 945        |      | 543     | 548  | 552           | 557  | 562  | 566     | 571  | 575            | 580  | 585  |         |
| 946        |      | 589     | 594  | 598           | 603  | 607  | 612     | 617  | 621            | 626  | 630  |         |
| 947        |      | 633     | 640  | 644           | 649  | 653  | 658     | 663  | 667            | 672  | 676  |         |
| 948        |      | 681     | 685  | 690           | 695  | 699  | 704     | 708  | 713            | 717  | 722  |         |
| 949        |      | 727     | 731  | 736           | 740  | 745  | 749     | 754  | 759            | 763  | 768  |         |
| <b>950</b> |      | 772     | 777  | 782           | 786  | 791  | 795     | 800  | 804            | 809  | 813  |         |
| N.         | L.   | 0       | 1    | 2             | 3    | 4    | 5       | 6    | 7              | 8    | 9    | P. P.   |
|            |      | S.' T.' |      |               |      |      | S.' T.' |      |                |      |      | S.' T.' |
| 9'         | 6.46 | 373 373 |      | 0° 15' = 900" |      | 4.68 | 557 558 |      | 2° 34' = 9240" |      | 4.68 | 543 587 |
| 10         |      | 373 373 |      | 0 16 = 960    |      |      | 557 558 |      | 2 35 = 9300    |      |      | 543 587 |
| 90         |      | 368 383 |      | 2 30 = 9000   |      |      | 544 585 |      | 2 36 = 9360    |      |      | 543 587 |
| 91         |      | 368 383 |      | 2 31 = 9060   |      |      | 544 585 |      | 2 37 = 9420    |      |      | 542 588 |
| 92         |      | 367 383 |      | 2 32 = 9120   |      |      | 543 586 |      | 2 38 = 9480    |      |      | 542 588 |
| 94         |      | 367 383 |      | 2 33 = 9180   |      |      | 543 586 |      | 2 39 = 9540    |      |      | 542 588 |
| 95         |      | 367 384 |      | 2 34 = 9240   |      |      | 543 587 |      |                |      |      |         |

| N.   | L.   | 0   | 1   | 2        | 3     | 4    | 5    | 6    | 7        | 8      | 9    | P. P.     |
|------|------|-----|-----|----------|-------|------|------|------|----------|--------|------|-----------|
| 950  | 97   | 772 | 777 | 782      | 786   | 791  | 795  | 800  | 804      | 809    | 813  |           |
| 951  |      | 818 | 823 | 827      | 832   | 836  | 841  | 845  | 850      | 855    | 859  |           |
| 952  |      | 864 | 868 | 873      | 877   | 882  | 886  | 891  | 896      | 900    | 905  |           |
| 953  |      | 909 | 914 | 918      | 923   | 928  | 932  | 937  | 941      | 946    | 950  |           |
| 954  |      | 955 | 959 | 964      | 968   | 973  | 978  | 982  | 987      | 991    | 996  |           |
| 955  | 98   | 000 | 005 | 009      | 014   | 019  | 023  | 028  | 032      | 037    | 041  |           |
| 956  |      | 046 | 050 | 055      | 059   | 064  | 068  | 073  | 078      | 082    | 087  |           |
| 957  |      | 091 | 096 | 100      | 105   | 109  | 114  | 118  | 123      | 127    | 132  |           |
| 958  |      | 137 | 141 | 146      | 150   | 155  | 159  | 164  | 168      | 173    | 177  |           |
| 959  |      | 182 | 186 | 191      | 195   | 200  | 204  | 209  | 214      | 218    | 223  |           |
| 960  |      | 227 | 232 | 236      | 241   | 245  | 250  | 254  | 259      | 263    | 268  |           |
| 961  |      | 272 | 277 | 281      | 286   | 290  | 295  | 299  | 304      | 308    | 313  | 5         |
| 962  |      | 318 | 322 | 327      | 331   | 336  | 340  | 345  | 349      | 354    | 358  | 1 0.5     |
| 963  |      | 363 | 367 | 372      | 376   | 381  | 385  | 390  | 394      | 399    | 403  | 2 1.0     |
| 964  |      | 408 | 412 | 417      | 421   | 426  | 430  | 435  | 439      | 444    | 448  | 3 1.5     |
| 965  |      | 453 | 457 | 462      | 466   | 471  | 475  | 480  | 484      | 489    | 493  | 4 2.0     |
| 966  |      | 498 | 502 | 507      | 511   | 516  | 520  | 525  | 529      | 534    | 538  | 5 2.5     |
| 967  |      | 543 | 547 | 552      | 556   | 561  | 565  | 570  | 574      | 579    | 583  | 6 3.0     |
| 968  |      | 588 | 592 | 597      | 601   | 605  | 610  | 614  | 619      | 623    | 628  | 7 3.5     |
| 969  |      | 632 | 637 | 641      | 646   | 650  | 655  | 659  | 664      | 668    | 673  | 8 4.0     |
| 970  |      | 677 | 682 | 686      | 691   | 695  | 700  | 704  | 709      | 713    | 717  | 9 4.5     |
| 971  |      | 722 | 726 | 731      | 735   | 740  | 744  | 749  | 753      | 758    | 762  |           |
| 972  |      | 767 | 771 | 776      | 780   | 784  | 789  | 793  | 798      | 802    | 807  |           |
| 973  |      | 811 | 816 | 820      | 825   | 829  | 834  | 838  | 843      | 847    | 851  |           |
| 974  |      | 856 | 860 | 865      | 869   | 874  | 878  | 883  | 887      | 892    | 896  |           |
| 975  |      | 900 | 905 | 909      | 914   | 918  | 923  | 927  | 932      | 936    | 941  |           |
| 976  |      | 945 | 949 | 954      | 958   | 963  | 967  | 972  | 976      | 981    | 985  |           |
| 977  |      | 989 | 994 | 998      | *003  | *007 | *012 | *016 | *021     | *025   | *029 |           |
| 978  | 99   | 034 | 038 | 043      | 047   | 052  | 056  | 061  | 065      | 069    | 074  |           |
| 979  |      | 078 | 083 | 087      | 092   | 096  | 100  | 105  | 109      | 114    | 118  |           |
| 980  |      | 123 | 127 | 131      | 136   | 140  | 145  | 149  | 154      | 158    | 162  | 4         |
| 981  |      | 167 | 171 | 176      | 180   | 185  | 189  | 193  | 198      | 202    | 207  | 1 0.4     |
| 982  |      | 211 | 216 | 220      | 224   | 229  | 233  | 238  | 242      | 247    | 251  | 2 0.8     |
| 983  |      | 255 | 260 | 264      | 269   | 273  | 277  | 282  | 286      | 291    | 295  | 3 1.2     |
| 984  |      | 300 | 304 | 308      | 313   | 317  | 322  | 326  | 330      | 335    | 339  | 4 1.6     |
| 985  |      | 344 | 348 | 352      | 357   | 361  | 366  | 370  | 374      | 379    | 383  | 5 2.0     |
| 986  |      | 388 | 392 | 396      | 401   | 405  | 410  | 414  | 419      | 423    | 427  | 6 2.4     |
| 987  |      | 432 | 436 | 441      | 445   | 449  | 454  | 458  | 463      | 467    | 471  | 7 2.8     |
| 988  |      | 476 | 480 | 484      | 489   | 493  | 498  | 502  | 506      | 511    | 515  | 8 3.2     |
| 989  |      | 520 | 524 | 528      | 533   | 537  | 542  | 546  | 550      | 555    | 559  | 9 3.6     |
| 990  |      | 564 | 568 | 572      | 577   | 581  | 585  | 590  | 594      | 599    | 603  |           |
| 991  |      | 607 | 612 | 616      | 621   | 625  | 629  | 634  | 638      | 642    | 647  |           |
| 992  |      | 651 | 656 | 660      | 664   | 669  | 673  | 677  | 682      | 686    | 691  |           |
| 993  |      | 695 | 699 | 704      | 708   | 712  | 717  | 721  | 726      | 730    | 734  |           |
| 994  |      | 739 | 743 | 747      | 752   | 756  | 760  | 765  | 769      | 774    | 778  |           |
| 995  |      | 782 | 787 | 791      | 795   | 800  | 804  | 808  | 813      | 817    | 822  |           |
| 996  |      | 826 | 830 | 835      | 839   | 843  | 848  | 852  | 856      | 861    | 865  |           |
| 997  |      | 870 | 874 | 878      | 883   | 887  | 891  | 896  | 900      | 904    | 909  |           |
| 998  |      | 913 | 917 | 922      | 926   | 930  | 935  | 939  | 944      | 948    | 952  |           |
| 999  |      | 957 | 961 | 965      | 970   | 974  | 978  | 983  | 987      | 991    | 996  |           |
| 1000 | 00   | 000 | 004 | 009      | 013   | 017  | 022  | 026  | 030      | 035    | 039  |           |
| N.   | L.   | 0   | 1   | 2        | 3     | 4    | 5    | 6    | 7        | 8      | 9    | P. P.     |
|      | S.'  | T.' |     |          |       |      | S.'' | T.'' |          |        |      | S.'' T.'' |
| 9'   | 6.46 | 373 | 373 | 0° 15' = | 900'' | 4.68 | 557  | 558  | 2° 41' = | 9660'' | 4.68 | 542 589   |
| 10   |      | 373 | 373 | 0 16 =   | 960   |      | 557  | 558  | 2 42 =   | 9720   |      | 541 590   |
| 95   | 367  | 384 |     | 0 17 =   | 1020  |      | 557  | 558  | 2 43 =   | 9780   |      | 541 590   |
| 98   | 367  | 384 |     | 2 38 =   | 9480  |      | 542  | 588  | 2 44 =   | 9840   |      | 541 590   |
| 99   | 367  | 385 |     | 2 39 =   | 9540  |      | 542  | 588  | 2 45 =   | 9900   |      | 541 591   |
| 100  | 366  | 385 |     | 2 40 =   | 9600  |      | 542  | 589  | 2 46 =   | 9960   |      | 541 591   |
|      |      |     |     | 2 41 =   | 9660  |      | 542  | 589  | 2 47 =   | 10020  |      | 540 592   |

| N.             | L.  | 0    | 1     | 2     | 3     | 4     | 5               | 6     | 7     | 8     | 9            |
|----------------|-----|------|-------|-------|-------|-------|-----------------|-------|-------|-------|--------------|
| <b>1000</b>    | 000 | 0000 | 0434  | 0869  | 1303  | 1737  | 2171            | 2605  | 3039  | 3473  | 3907         |
| 1001           |     | 4341 | 4775  | 5208  | 5642  | 6076  | 6510            | 6943  | 7377  | 7810  | 8244         |
| 1002           |     | 8677 | 9111  | 9544  | 9977  | *0411 | *0844           | *1277 | *1710 | *2143 | *2576        |
| 1003           | 001 | 3009 | 3442  | 3875  | 4308  | 4741  | 5174            | 5607  | 6039  | 6472  | 6905         |
| 1004           |     | 7337 | 7770  | 8202  | 8635  | 9067  | 9499            | 9932  | *0364 | *0796 | *1228        |
| 1005           | 002 | 1661 | 2093  | 2525  | 2957  | 3389  | 3821            | 4253  | 4685  | 5116  | 5548         |
| 1006           |     | 5980 | 6411  | 6843  | 7275  | 7706  | 8138            | 8569  | 9001  | 9432  | 9863         |
| 1007           | 003 | 0295 | 0726  | 1157  | 1588  | 2019  | 2451            | 2882  | 3313  | 3744  | 4174         |
| 1008           |     | 4605 | 5036  | 5467  | 5898  | 6328  | 6759            | 7190  | 7620  | 8051  | 8481         |
| 1009           |     | 8912 | 9342  | 9772  | *0203 | *0633 | *1063           | *1493 | *1924 | *2354 | *2784        |
| <b>1010</b>    | 004 | 3214 | 3644  | 4074  | 4504  | 4933  | 5363            | 5793  | 6223  | 6652  | 7082         |
| 1011           |     | 7512 | 7941  | 8371  | 8800  | 9229  | 9659            | *0088 | *0517 | *0947 | *1376        |
| 1012           | 005 | 1805 | 2234  | 2663  | 3092  | 3521  | 3950            | 4379  | 4808  | 5237  | 5666         |
| 1013           |     | 6094 | 6523  | 6952  | 7380  | 7809  | 8238            | 8666  | 9094  | 9523  | 9951         |
| 1014           | 006 | 0380 | 0808  | 1236  | 1664  | 2092  | 2521            | 2949  | 3377  | 3805  | 4233         |
| 1015           |     | 4660 | 5088  | 5516  | 5944  | 6372  | 6799            | 7227  | 7655  | 8082  | 8510         |
| 1016           |     | 8937 | 9365  | 9792  | *0219 | *0647 | *1074           | *1501 | *1928 | *2355 | *2782        |
| 1017           | 007 | 3210 | 3637  | 4064  | 4490  | 4917  | 5344            | 5771  | 6198  | 6624  | 7051         |
| 1018           |     | 7478 | 7904  | 8331  | 8757  | 9184  | 9610            | *0037 | *0463 | *0889 | *1316        |
| 1019           | 008 | 1742 | 2168  | 2594  | 3020  | 3446  | 3872            | 4298  | 4724  | 5150  | 5576         |
| <b>1020</b>    |     | 6002 | 6427  | 6853  | 7279  | 7704  | 8130            | 8556  | 8981  | 9407  | 9832         |
| 1021           | 009 | 0257 | 0683  | 1108  | 1533  | 1959  | 2384            | 2809  | 3234  | 3659  | 4084         |
| 1022           |     | 4509 | 4934  | 5359  | 5784  | 6208  | 6633            | 7058  | 7483  | 7907  | 8332         |
| 1023           |     | 8756 | 9181  | 9605  | *0030 | *0454 | *0878           | *1303 | *1727 | *2151 | *2575        |
| 1024           | 010 | 3000 | 3424  | 3848  | 4272  | 4696  | 5120            | 5544  | 5967  | 6391  | 6815         |
| 1025           |     | 7239 | 7662  | 8086  | 8510  | 8933  | 9357            | 9780  | *0204 | *0627 | *1050        |
| 1026           | 011 | 1474 | 1897  | 2320  | 2743  | 3166  | 3590            | 4013  | 4436  | 4859  | 5282         |
| 1027           |     | 5704 | 6127  | 6550  | 6973  | 7396  | 7818            | 8241  | 8664  | 9086  | 9509         |
| 1028           |     | 9931 | *0354 | *0776 | *1198 | *1621 | *2043           | *2465 | *2887 | *3310 | *3732        |
| 1029           | 012 | 4154 | 4576  | 4998  | 5420  | 5842  | 6264            | 6685  | 7107  | 7529  | 7951         |
| <b>1030</b>    |     | 8372 | 8794  | 9215  | 9637  | *0059 | *0480           | *0901 | *1323 | *1744 | *2165        |
| 1031           | 013 | 2587 | 3008  | 3429  | 3850  | 4271  | 4692            | 5113  | 5534  | 5955  | 6376         |
| 1032           |     | 6797 | 7218  | 7639  | 8059  | 8480  | 8901            | 9321  | 9742  | *0162 | *0583        |
| 1033           | 014 | 1003 | 1424  | 1844  | 2264  | 2685  | 3105            | 3525  | 3945  | 4365  | 4785         |
| 1034           |     | 5205 | 5625  | 6045  | 6465  | 6885  | 7305            | 7725  | 8144  | 8564  | 8984         |
| 1035           |     | 9403 | 9823  | *0243 | *0662 | *1082 | *1501           | *1920 | *2340 | *2759 | *3178        |
| 1036           | 015 | 3598 | 4017  | 4436  | 4855  | 5274  | 5693            | 6112  | 6531  | 6950  | 7369         |
| 1037           |     | 7788 | 8206  | 8625  | 9044  | 9462  | 9881            | *0300 | *0718 | *1137 | *1555        |
| 1038           | 016 | 1974 | 2392  | 2810  | 3229  | 3647  | 4065            | 4483  | 4901  | 5319  | 5737         |
| 1039           |     | 6155 | 6573  | 6991  | 7409  | 7827  | 8245            | 8663  | 9080  | 9498  | 9916         |
| <b>1040</b>    | 017 | 0333 | 0751  | 1168  | 1586  | 2003  | 2421            | 2838  | 3256  | 3673  | 4090         |
| 1041           |     | 4507 | 4924  | 5342  | 5759  | 6176  | 6593            | 7010  | 7427  | 7844  | 8260         |
| 1042           |     | 8677 | 9094  | 9511  | 9927  | *0344 | *0761           | *1177 | *1594 | *2010 | *2426        |
| 1043           | 018 | 2843 | 3259  | 3676  | 4092  | 4508  | 4925            | 5341  | 5757  | 6173  | 6589         |
| 1044           |     | 7005 | 7421  | 7837  | 8253  | 8669  | 9084            | 9500  | 9916  | *0332 | *0747        |
| 1045           | 019 | 1163 | 1578  | 1994  | 2410  | 2825  | 3240            | 3656  | 4071  | 4486  | 4902         |
| 1046           |     | 5317 | 5732  | 6147  | 6562  | 6977  | 7392            | 7807  | 8222  | 8637  | 9052         |
| 1047           |     | 9467 | 9882  | *0296 | *0711 | *1126 | *1540           | *1955 | *2369 | *2784 | *3198        |
| 1048           | 020 | 3613 | 4027  | 4442  | 4856  | 5270  | 5684            | 6099  | 6513  | 6927  | 7341         |
| 1049           |     | 7755 | 8169  | 8583  | 8997  | 9411  | 9824            | *0238 | *0652 | *1066 | *1479        |
| <b>1050</b>    | 021 | 1893 | 2307  | 2720  | 3134  | 3547  | 3961            | 4374  | 4787  | 5201  | 5614         |
| N.             | L.  | 0    | 1     | 2     | 3     | 4     | 5               | 6     | 7     | 8     | 9            |
|                |     |      |       | S."   | T."   |       |                 |       |       | S."   | T."          |
| 2° 46' = 9960" |     |      |       | 4.68  | 541   | 591   | 2° 51' = 10260" |       |       |       | 4.68 540 593 |
| 2 47 = 10020   |     |      |       |       | 540   | 592   | 2 52 = 10320    |       |       |       | 539 594      |
| 2 48 = 10080   |     |      |       |       | 540   | 592   | 2 53 = 10380    |       |       |       | 539 594      |
| 2 49 = 10140   |     |      |       |       | 540   | 592   | 2 54 = 10440    |       |       |       | 539 595      |
| 2 50 = 10200   |     |      |       |       | 540   | 593   | 2 55 = 10500    |       |       |       | 539 595      |

| N.           | L.  | 0    | 1     | 2      | 3        | 4     | 5     | 6              | 7        | 8     | 9     |
|--------------|-----|------|-------|--------|----------|-------|-------|----------------|----------|-------|-------|
| <b>1050</b>  | 021 | 1893 | 2307  | 2720   | 3134     | 3547  | 3961  | 4374           | 4787     | 5201  | 5614  |
| 1051         |     | 6027 | 6440  | 6854   | 7267     | 7680  | 8093  | 8506           | 8919     | 9332  | 9745  |
| 1052         | 022 | 0157 | 0570  | 0983   | 1396     | 1808  | 2221  | 2634           | 3046     | 3459  | 3871  |
| 1053         |     | 4284 | 4696  | 5109   | 5521     | 5933  | 6345  | 6758           | 7170     | 7582  | 7994  |
| 1054         |     | 8406 | 8818  | 9230   | 9642     | *0054 | *0466 | *0878          | *1289    | *1701 | *2113 |
| 1055         | 023 | 2523 | 2936  | 3348   | 3759     | 4171  | 4582  | 4994           | 5405     | 5817  | 6228  |
| 1056         |     | 6639 | 7050  | 7462   | 7873     | 8284  | 8695  | 9106           | 9517     | 9928  | *0339 |
| 1057         | 024 | 0750 | 1161  | 1572   | 1982     | 2393  | 2804  | 3214           | 3625     | 4036  | 4446  |
| 1058         |     | 4857 | 5267  | 5678   | 6088     | 6498  | 6909  | 7319           | 7729     | 8139  | 8549  |
| 1059         |     | 8960 | 9370  | 9780   | *0190    | *0600 | *1010 | *1419          | *1829    | *2239 | *2649 |
| <b>1060</b>  | 025 | 3059 | 3468  | 3878   | 4288     | 4697  | 5107  | 5516           | 5926     | 6335  | 6744  |
| 1061         |     | 7154 | 7563  | 7972   | 8382     | 8791  | 9200  | 9609           | *0018    | *0427 | *0836 |
| 1062         | 026 | 1245 | 1654  | 2063   | 2472     | 2881  | 3289  | 3698           | 4107     | 4515  | 4924  |
| 1063         |     | 5333 | 5741  | 6150   | 6558     | 6967  | 7375  | 7783           | 8192     | 8600  | 9008  |
| 1064         |     | 9416 | 9824  | *0233  | *0641    | *1049 | *1457 | *1865          | *2273    | *2680 | *3088 |
| 1065         | 027 | 3496 | 3904  | 4312   | 4719     | 5127  | 5535  | 5942           | 6350     | 6757  | 7165  |
| 1066         |     | 7572 | 7979  | 8387   | 8794     | 9201  | 9609  | *0016          | *0423    | *0830 | *1237 |
| 1067         | 028 | 1644 | 2051  | 2458   | 2865     | 3272  | 3679  | 4086           | 4492     | 4899  | 5306  |
| 1068         |     | 5713 | 6119  | 6526   | 6932     | 7339  | 7745  | 8152           | 8558     | 8964  | 9371  |
| 1069         |     | 9777 | *0183 | *0590  | *0996    | *1402 | *1808 | *2214          | *2620    | *3026 | *3432 |
| <b>1070</b>  | 029 | 3838 | 4244  | 4649   | 5055     | 5461  | 5867  | 6272           | 6678     | 7084  | 7489  |
| 1071         |     | 7895 | 8300  | 8706   | 9111     | 9516  | 9922  | *0327          | *0732    | *1138 | *1543 |
| 1072         | 030 | 1948 | 2353  | 2758   | 3163     | 3568  | 3973  | 4378           | 4783     | 5188  | 5592  |
| 1073         |     | 5997 | 6402  | 6807   | 7211     | 7616  | 8020  | 8425           | 8830     | 9234  | 9638  |
| 1074         | 031 | 0043 | 0447  | 0851   | 1256     | 1660  | 2064  | 2468           | 2872     | 3277  | 3681  |
| 1075         |     | 4085 | 4489  | 4893   | 5296     | 5700  | 6104  | 6508           | 6912     | 7315  | 7719  |
| 1076         |     | 8123 | 8526  | 8930   | 9333     | 9737  | *0140 | *0544          | *0947    | *1350 | *1754 |
| 1077         | 032 | 2157 | 2560  | 2963   | 3367     | 3770  | 4173  | 4576           | 4979     | 5382  | 5785  |
| 1078         |     | 6188 | 6590  | 6993   | 7396     | 7799  | 8201  | 8604           | 9007     | 9409  | 9812  |
| 1079         | 033 | 0214 | 0617  | 1019   | 1422     | 1824  | 2226  | 2629           | 3031     | 3433  | 3835  |
| <b>1080</b>  |     | 4238 | 4640  | 5042   | 5444     | 5846  | 6248  | 6650           | 7052     | 7453  | 7855  |
| 1081         |     | 8257 | 8659  | 9060   | 9462     | 9864  | *0265 | *0667          | *1068    | *1470 | *1871 |
| 1082         | 034 | 2273 | 2674  | 3075   | 3477     | 3878  | 4279  | 4680           | 5081     | 5482  | 5884  |
| 1083         |     | 6285 | 6686  | 7087   | 7487     | 7888  | 8289  | 8690           | 9091     | 9491  | 9892  |
| 1084         | 035 | 0293 | 0693  | 1094   | 1495     | 1895  | 2296  | 2696           | 3096     | 3497  | 3897  |
| 1085         |     | 4297 | 4698  | 5098   | 5498     | 5898  | 6298  | 6698           | 7098     | 7498  | 7898  |
| 1086         |     | 8298 | 8698  | 9098   | 9498     | 9898  | *0297 | *0697          | *1097    | *1496 | *1896 |
| 1087         | 036 | 2295 | 2695  | 3094   | 3494     | 3893  | 4293  | 4692           | 5091     | 5491  | 5890  |
| 1088         |     | 6289 | 6688  | 7087   | 7486     | 7885  | 8284  | 8683           | 9082     | 9481  | 9880  |
| 1089         | 037 | 0279 | 0678  | 1076   | 1475     | 1874  | 2272  | 2671           | 3070     | 3468  | 3867  |
| <b>1090</b>  |     | 4265 | 4663  | 5062   | 5460     | 5858  | 6257  | 6655           | 7053     | 7451  | 7849  |
| 1091         |     | 8248 | 8646  | 9044   | 9442     | 9839  | *0237 | *0635          | *1033    | *1431 | *1829 |
| 1092         | 038 | 2226 | 2624  | 3022   | 3419     | 3817  | 4214  | 4612           | 5009     | 5407  | 5804  |
| 1093         |     | 6202 | 6599  | 6996   | 7393     | 7791  | 8188  | 8585           | 8982     | 9379  | 9776  |
| 1094         | 039 | 0173 | 0570  | 0967   | 1364     | 1761  | 2158  | 2554           | 2951     | 3348  | 3745  |
| 1095         |     | 4141 | 4538  | 4934   | 5331     | 5727  | 6124  | 6520           | 6917     | 7313  | 7709  |
| 1096         |     | 8106 | 8502  | 8898   | 9294     | 9690  | *0086 | *0482          | *0878    | *1274 | *1670 |
| 1097         | 040 | 2066 | 2462  | 2858   | 3254     | 3650  | 4045  | 4441           | 4837     | 5232  | 5628  |
| 1098         |     | 6023 | 6419  | 6814   | 7210     | 7605  | 8001  | 8396           | 8791     | 9187  | 9582  |
| 1099         |     | 9977 | *0372 | *0767  | *1162    | *1557 | *1952 | *2347          | *2742    | *3137 | *3532 |
| <b>1100</b>  | 041 | 3927 | 4322  | 4716   | 5111     | 5506  | 5900  | 6295           | 6690     | 7084  | 7479  |
| N.           | L.  | 0    | 1     | 2      | 3        | 4     | 5     | 6              | 7        | 8     | 9     |
|              |     |      |       | S."    | T."      |       |       |                |          | S."   | T."   |
| 2° 55'       |     |      |       | 10500" | 4.68 539 | 595   |       | 3° 0' = 10800" | 4.68 538 | 597   |       |
| 2 56 = 10560 |     |      |       |        | 539      | 595   |       | 3 1 = 10860    | 537      | 598   |       |
| 2 57 = 10620 |     |      |       |        | 538      | 596   |       | 3 2 = 10920    | 537      | 598   |       |
| 2 58 = 10680 |     |      |       |        | 538      | 596   |       | 3 3 = 10980    | 537      | 599   |       |
| 2 59 = 10740 |     |      |       |        | 538      | 597   |       | 3 4 = 11040    | 537      | 599   |       |

|    | M.  | S'   | T'  | Sec.  | S''  | T'' |
|----|-----|------|-----|-------|------|-----|
|    |     | 6.46 |     |       | 4.68 |     |
| 0  | 180 | 353  | 412 | 10800 | 538  | 597 |
| 1  | 181 | 353  | 413 | 10860 | 537  | 598 |
| 2  | 182 | 352  | 413 | 10920 | 537  | 598 |
| 3  | 183 | 352  | 414 | 10980 | 537  | 599 |
| 4  | 184 | 352  | 414 | 11040 | 537  | 599 |
| 5  | 185 | 352  | 415 | 11100 | 537  | 599 |
| 6  | 186 | 351  | 415 | 11160 | 536  | 600 |
| 7  | 187 | 351  | 415 | 11220 | 536  | 600 |
| 8  | 188 | 351  | 416 | 11280 | 536  | 601 |
| 9  | 189 | 351  | 416 | 11340 | 536  | 601 |
| 10 | 190 | 350  | 417 | 11400 | 535  | 602 |
| 11 | 191 | 350  | 417 | 11460 | 535  | 602 |
| 12 | 192 | 350  | 418 | 11520 | 535  | 603 |
| 13 | 193 | 350  | 418 | 11580 | 535  | 603 |
| 14 | 194 | 350  | 419 | 11640 | 534  | 604 |
| 15 | 195 | 349  | 419 | 11700 | 534  | 604 |
| 16 | 196 | 349  | 420 | 11760 | 534  | 605 |
| 17 | 197 | 349  | 420 | 11820 | 534  | 605 |
| 18 | 198 | 349  | 421 | 11880 | 533  | 606 |
| 19 | 199 | 348  | 421 | 11940 | 533  | 606 |
| 20 | 200 | 348  | 422 | 12000 | 533  | 607 |
| 21 | 201 | 348  | 422 | 12060 | 533  | 607 |
| 22 | 202 | 348  | 423 | 12120 | 532  | 608 |
| 23 | 203 | 347  | 423 | 12180 | 532  | 608 |
| 24 | 204 | 347  | 424 | 12240 | 532  | 609 |
| 25 | 205 | 347  | 424 | 12300 | 532  | 609 |
| 26 | 206 | 347  | 425 | 12360 | 531  | 610 |
| 27 | 207 | 346  | 425 | 12420 | 531  | 610 |
| 28 | 208 | 346  | 426 | 12480 | 531  | 611 |
| 29 | 209 | 346  | 426 | 12540 | 531  | 611 |
| 30 | 210 | 346  | 427 | 12600 | 530  | 612 |
| 31 | 211 | 345  | 427 | 12660 | 530  | 612 |
| 32 | 212 | 345  | 428 | 12720 | 530  | 613 |
| 33 | 213 | 345  | 428 | 12780 | 530  | 613 |
| 34 | 214 | 345  | 429 | 12840 | 529  | 614 |
| 35 | 215 | 344  | 429 | 12900 | 529  | 614 |
| 36 | 216 | 344  | 430 | 12960 | 529  | 615 |
| 37 | 217 | 344  | 430 | 13020 | 529  | 615 |
| 38 | 218 | 344  | 431 | 13080 | 528  | 616 |
| 39 | 219 | 343  | 431 | 13140 | 528  | 616 |
| 40 | 220 | 343  | 432 | 13200 | 528  | 617 |
| 41 | 221 | 343  | 432 | 13260 | 528  | 617 |
| 42 | 222 | 342  | 433 | 13320 | 527  | 618 |
| 43 | 223 | 342  | 434 | 13380 | 527  | 618 |
| 44 | 224 | 342  | 434 | 13440 | 527  | 619 |
| 45 | 225 | 342  | 435 | 13500 | 526  | 620 |
| 46 | 226 | 341  | 435 | 13560 | 526  | 620 |
| 47 | 227 | 341  | 436 | 13620 | 526  | 621 |
| 48 | 228 | 341  | 436 | 13680 | 526  | 621 |
| 49 | 229 | 340  | 437 | 13740 | 525  | 622 |
| 50 | 230 | 340  | 437 | 13800 | 525  | 622 |
| 51 | 231 | 340  | 438 | 13860 | 525  | 623 |
| 52 | 232 | 340  | 439 | 13920 | 525  | 623 |
| 53 | 233 | 339  | 439 | 13980 | 524  | 624 |
| 54 | 234 | 339  | 440 | 14040 | 524  | 625 |
| 55 | 235 | 339  | 440 | 14100 | 524  | 625 |
| 56 | 236 | 338  | 441 | 14160 | 523  | 626 |
| 57 | 237 | 338  | 441 | 14220 | 523  | 626 |
| 58 | 238 | 338  | 442 | 14280 | 523  | 627 |
| 59 | 239 | 338  | 443 | 14340 | 522  | 628 |
| 60 | 240 | 337  | 443 | 14400 | 522  | 628 |

|    | M.  | S'   | T'  | Sec.  | S''  | T'' |
|----|-----|------|-----|-------|------|-----|
|    |     | 6.46 |     |       | 4.68 |     |
| 0  | 240 | 337  | 443 | 14400 | 522  | 628 |
| 1  | 241 | 337  | 444 | 14460 | 522  | 629 |
| 2  | 242 | 337  | 444 | 14520 | 522  | 629 |
| 3  | 243 | 336  | 445 | 14580 | 521  | 630 |
| 4  | 244 | 336  | 446 | 14640 | 521  | 631 |
| 5  | 245 | 336  | 446 | 14700 | 521  | 631 |
| 6  | 246 | 336  | 447 | 14760 | 520  | 632 |
| 7  | 247 | 335  | 447 | 14820 | 520  | 632 |
| 8  | 248 | 335  | 448 | 14880 | 520  | 633 |
| 9  | 249 | 335  | 449 | 14940 | 520  | 634 |
| 10 | 250 | 334  | 449 | 15000 | 519  | 634 |
| 11 | 251 | 334  | 450 | 15060 | 519  | 635 |
| 12 | 252 | 334  | 450 | 15120 | 519  | 635 |
| 13 | 253 | 333  | 451 | 15180 | 518  | 636 |
| 14 | 254 | 333  | 452 | 15240 | 518  | 637 |
| 15 | 255 | 333  | 452 | 15300 | 518  | 637 |
| 16 | 256 | 332  | 453 | 15360 | 517  | 638 |
| 17 | 257 | 332  | 454 | 15420 | 517  | 638 |
| 18 | 258 | 332  | 454 | 15480 | 517  | 639 |
| 19 | 259 | 332  | 455 | 15540 | 516  | 640 |
| 20 | 260 | 331  | 456 | 15600 | 516  | 640 |
| 21 | 261 | 331  | 456 | 15660 | 516  | 641 |
| 22 | 262 | 331  | 457 | 15720 | 515  | 642 |
| 23 | 263 | 330  | 457 | 15780 | 515  | 642 |
| 24 | 264 | 330  | 458 | 15840 | 515  | 643 |
| 25 | 265 | 330  | 459 | 15900 | 514  | 644 |
| 26 | 266 | 329  | 459 | 15960 | 514  | 644 |
| 27 | 267 | 329  | 460 | 16020 | 514  | 645 |
| 28 | 268 | 329  | 461 | 16080 | 513  | 646 |
| 29 | 269 | 328  | 461 | 16140 | 513  | 646 |
| 30 | 270 | 328  | 462 | 16200 | 513  | 647 |
| 31 | 271 | 328  | 463 | 16260 | 512  | 648 |
| 32 | 272 | 327  | 463 | 16320 | 512  | 648 |
| 33 | 273 | 327  | 464 | 16380 | 512  | 649 |
| 34 | 274 | 327  | 465 | 16440 | 511  | 650 |
| 35 | 275 | 326  | 465 | 16500 | 511  | 650 |
| 36 | 276 | 326  | 466 | 16560 | 511  | 651 |
| 37 | 277 | 326  | 467 | 16620 | 510  | 652 |
| 38 | 278 | 325  | 467 | 16680 | 510  | 652 |
| 39 | 279 | 325  | 468 | 16740 | 510  | 653 |
| 40 | 280 | 325  | 469 | 16800 | 509  | 654 |
| 41 | 281 | 324  | 469 | 16860 | 509  | 654 |
| 42 | 282 | 324  | 470 | 16920 | 509  | 655 |
| 43 | 283 | 324  | 471 | 16980 | 508  | 656 |
| 44 | 284 | 323  | 472 | 17040 | 508  | 656 |
| 45 | 285 | 323  | 472 | 17100 | 508  | 657 |
| 46 | 286 | 323  | 473 | 17160 | 507  | 658 |
| 47 | 287 | 322  | 474 | 17220 | 507  | 659 |
| 48 | 288 | 322  | 474 | 17280 | 507  | 659 |
| 49 | 289 | 321  | 475 | 17340 | 506  | 660 |
| 50 | 290 | 321  | 476 | 17400 | 506  | 661 |
| 51 | 291 | 321  | 477 | 17460 | 506  | 661 |
| 52 | 292 | 320  | 477 | 17520 | 505  | 662 |
| 53 | 293 | 320  | 478 | 17580 | 505  | 663 |
| 54 | 294 | 320  | 479 | 17640 | 505  | 664 |
| 55 | 295 | 319  | 479 | 17700 | 504  | 664 |
| 56 | 296 | 319  | 480 | 17760 | 504  | 665 |
| 57 | 297 | 319  | 481 | 17820 | 503  | 666 |
| 58 | 298 | 318  | 482 | 17880 | 503  | 666 |
| 59 | 299 | 318  | 482 | 17940 | 503  | 667 |
| 60 | 300 | 317  | 483 | 18000 | 502  | 668 |

## II.

# THE LOGARITHMS OF THE TRIGONOMETRIC FUNCTIONS FOR EACH MINUTE.

### Formulas for the Use of the Auxiliaries $S$ and $T$ .

1. When  $a$  is in the first five degrees of the quadrant:

$$\begin{array}{ll} \log \sin a = \log a' + S.' & \log a' = \log \sin a + \text{cpl } S.' \\ \log \tan a = \log a' + T.' & = \log \tan a + \text{cpl } T.' \\ \log \cot a = \text{cpl } \log \tan a. & = \text{cpl } \log \cot a + \text{cpl } T.' \\ \log \sin a = \log a'' + S.'' & \log a'' = \log \sin a + \text{cpl } S.'' \\ \log \tan a = \log a'' + T.'' & = \log \tan a + \text{cpl } T.'' \\ \log \cot a = \text{cpl } \log \tan a. & = \text{cpl } \log \cot a + \text{cpl } T.'' \end{array}$$

2. When  $a$  is in the last five degrees of the quadrant:

$$\begin{array}{ll} \log \cos a = \log(90^\circ - a)' + S.' & \log(90^\circ - a)' = \log \cos a + \text{cpl } S.' \\ \log \cot a = \log(90^\circ - a)' + T.' & = \log \cot a + \text{cpl } T.' \\ \log \tan a = \text{cpl } \log \cot a. & = \text{cpl } \log \tan a + \text{cpl } T.' \\ \log \cos a = \log(90^\circ - a)'' + S.'' & \log(90^\circ - a)'' = \log \cos a + \text{cpl } S.'' \\ \log \cot a = \log(90^\circ - a)'' + T.'' & = \log \cot a + \text{cpl } T.'' \\ \log \tan a = \text{cpl } \log \cot a. & = \text{cpl } \log \tan a + \text{cpl } T.'' \end{array}$$

$$a = 90^\circ - (90^\circ - a).$$

| "    | '  | L. Sin.  | d.    | Cpl. S'  | Cpl. T'  | L. Tan.  | c. d. | L. Cot.  | L. Cos.  |    |
|------|----|----------|-------|----------|----------|----------|-------|----------|----------|----|
| 0    | 0  | —        | —     | —        | —        | —        | —     | —        | 0.00 000 | 60 |
| 60   | 1  | 6.46 373 | 30103 | 3.53 627 | 3.53 627 | 6.46 373 | 30103 | 3.53 627 | 0.00 000 | 59 |
| 120  | 2  | 6.76 470 | 17609 | 3.53 627 | 3.53 627 | 6.76 470 | 17609 | 3.23 524 | 0.00 000 | 58 |
| 180  | 3  | 6.94 085 | 12494 | 3.53 627 | 3.53 627 | 6.94 085 | 12494 | 3.05 915 | 0.00 000 | 57 |
| 240  | 4  | 7.06 579 | 9691  | 3.53 627 | 3.53 627 | 7.06 579 | 9691  | 2.93 421 | 0.00 000 | 56 |
| 300  | 5  | 7.16 270 | 7918  | 3.53 627 | 3.53 627 | 7.16 270 | 7918  | 2.83 730 | 0.00 000 | 55 |
| 360  | 6  | 7.24 188 | 6694  | 3.53 627 | 3.53 627 | 7.24 188 | 6694  | 2.75 812 | 0.00 000 | 54 |
| 420  | 7  | 7.30 882 | 5800  | 3.53 627 | 3.53 627 | 7.30 882 | 5800  | 2.69 118 | 0.00 000 | 53 |
| 480  | 8  | 7.36 682 | 5115  | 3.53 627 | 3.53 627 | 7.36 682 | 5115  | 2.63 318 | 0.00 000 | 52 |
| 540  | 9  | 7.41 797 | 4576  | 3.53 627 | 3.53 627 | 7.41 797 | 4576  | 2.58 203 | 0.00 000 | 51 |
| 600  | 10 | 7.46 373 | 4139  | 3.53 627 | 3.53 627 | 7.46 373 | 4139  | 2.53 627 | 0.00 000 | 50 |
| 660  | 11 | 7.50 512 | 3779  | 3.53 627 | 3.53 627 | 7.50 512 | 3779  | 2.49 488 | 0.00 000 | 49 |
| 720  | 12 | 7.54 291 | 3476  | 3.53 627 | 3.53 627 | 7.54 291 | 3476  | 2.45 709 | 0.00 000 | 48 |
| 780  | 13 | 7.57 767 | 3218  | 3.53 627 | 3.53 627 | 7.57 767 | 3218  | 2.42 233 | 0.00 000 | 47 |
| 840  | 14 | 7.60 985 | 2997  | 3.53 628 | 3.53 627 | 7.60 986 | 2996  | 2.39 014 | 0.00 000 | 46 |
| 900  | 15 | 7.63 982 | 2802  | 3.53 628 | 3.53 627 | 7.63 982 | 2803  | 2.36 018 | 0.00 000 | 45 |
| 960  | 16 | 7.66 784 | 2633  | 3.53 628 | 3.53 627 | 7.66 785 | 2633  | 2.33 215 | 0.00 000 | 44 |
| 1020 | 17 | 7.69 417 | 2482  | 3.53 628 | 3.53 627 | 7.69 418 | 2482  | 2.30 582 | 0.99 999 | 43 |
| 1080 | 18 | 7.71 900 | 2348  | 3.53 628 | 3.53 627 | 7.71 900 | 2348  | 2.28 100 | 0.99 999 | 42 |
| 1140 | 19 | 7.74 248 | 2227  | 3.53 628 | 3.53 627 | 7.74 248 | 2228  | 2.25 752 | 0.99 999 | 41 |
| 1200 | 20 | 7.76 475 | 2119  | 3.53 628 | 3.53 627 | 7.76 476 | 2119  | 2.23 524 | 0.99 999 | 40 |
| 1260 | 21 | 7.78 594 | 2021  | 3.53 628 | 3.53 627 | 7.78 595 | 2020  | 2.21 405 | 0.99 999 | 39 |
| 1320 | 22 | 7.80 615 | 1930  | 3.53 628 | 3.53 627 | 7.80 615 | 1931  | 2.19 385 | 0.99 999 | 38 |
| 1380 | 23 | 7.82 545 | 1848  | 3.53 628 | 3.53 627 | 7.82 546 | 1848  | 2.17 454 | 0.99 999 | 37 |
| 1440 | 24 | 7.84 393 | 1773  | 3.53 628 | 3.53 627 | 7.84 394 | 1773  | 2.15 606 | 0.99 999 | 36 |
| 1500 | 25 | 7.86 166 | 1704  | 3.53 628 | 3.53 627 | 7.86 167 | 1704  | 2.13 833 | 0.99 999 | 35 |
| 1560 | 26 | 7.87 870 | 1639  | 3.53 628 | 3.53 627 | 7.87 871 | 1639  | 2.12 129 | 0.99 999 | 34 |
| 1620 | 27 | 7.89 509 | 1579  | 3.53 628 | 3.53 626 | 7.89 510 | 1579  | 2.10 490 | 0.99 999 | 33 |
| 1680 | 28 | 7.91 088 | 1524  | 3.53 628 | 3.53 626 | 7.91 089 | 1524  | 2.08 911 | 0.99 999 | 32 |
| 1740 | 29 | 7.92 612 | 1472  | 3.53 628 | 3.53 626 | 7.92 613 | 1473  | 2.07 387 | 0.99 998 | 31 |
| 1800 | 30 | 7.94 084 | 1424  | 3.53 628 | 3.53 626 | 7.94 086 | 1424  | 2.05 914 | 0.99 998 | 30 |
| 1860 | 31 | 7.95 508 | 1379  | 3.53 628 | 3.53 626 | 7.95 510 | 1379  | 2.04 490 | 0.99 998 | 29 |
| 1920 | 32 | 7.96 887 | 1336  | 3.53 628 | 3.53 626 | 7.96 889 | 1336  | 2.03 111 | 0.99 998 | 28 |
| 1980 | 33 | 7.98 223 | 1297  | 3.53 628 | 3.53 626 | 7.98 225 | 1297  | 2.01 775 | 0.99 998 | 27 |
| 2040 | 34 | 7.99 520 | 1259  | 3.53 628 | 3.53 626 | 7.99 522 | 1259  | 2.00 478 | 0.99 998 | 26 |
| 2100 | 35 | 8.00 779 | 1223  | 3.53 628 | 3.53 626 | 8.00 781 | 1223  | 1.99 219 | 0.99 998 | 25 |
| 2160 | 36 | 8.02 002 | 1190  | 3.53 628 | 3.53 626 | 8.02 004 | 1190  | 1.97 996 | 0.99 998 | 24 |
| 2220 | 37 | 8.03 192 | 1158  | 3.53 628 | 3.53 626 | 8.03 194 | 1159  | 1.96 806 | 0.99 997 | 23 |
| 2280 | 38 | 8.04 350 | 1128  | 3.53 628 | 3.53 626 | 8.04 353 | 1128  | 1.95 647 | 0.99 997 | 22 |
| 2340 | 39 | 8.05 478 | 1100  | 3.53 628 | 3.53 626 | 8.05 481 | 1100  | 1.94 519 | 0.99 997 | 21 |
| 2400 | 40 | 8.06 578 | 1072  | 3.53 628 | 3.53 625 | 8.06 581 | 1072  | 1.93 419 | 0.99 997 | 20 |
| 2460 | 41 | 8.07 650 | 1046  | 3.53 628 | 3.53 625 | 8.07 653 | 1047  | 1.92 347 | 0.99 997 | 19 |
| 2520 | 42 | 8.08 696 | 1022  | 3.53 628 | 3.53 625 | 8.08 700 | 1022  | 1.91 300 | 0.99 997 | 18 |
| 2580 | 43 | 8.09 718 | 999   | 3.53 629 | 3.53 625 | 8.09 722 | 998   | 1.90 278 | 0.99 997 | 17 |
| 2640 | 44 | 8.10 717 | 976   | 3.53 629 | 3.53 625 | 8.10 720 | 976   | 1.89 280 | 0.99 996 | 16 |
| 2700 | 45 | 8.11 693 | 954   | 3.53 629 | 3.53 625 | 8.11 696 | 955   | 1.88 304 | 0.99 996 | 15 |
| 2760 | 46 | 8.12 647 | 934   | 3.53 629 | 3.53 625 | 8.12 651 | 934   | 1.87 349 | 0.99 996 | 14 |
| 2820 | 47 | 8.13 581 | 914   | 3.53 629 | 3.53 625 | 8.13 585 | 915   | 1.86 415 | 0.99 996 | 13 |
| 2880 | 48 | 8.14 495 | 896   | 3.53 629 | 3.53 625 | 8.14 500 | 895   | 1.85 500 | 0.99 996 | 12 |
| 2940 | 49 | 8.15 391 | 877   | 3.53 629 | 3.53 624 | 8.15 395 | 878   | 1.84 605 | 0.99 996 | 11 |
| 3000 | 50 | 8.16 268 | 860   | 3.53 629 | 3.53 624 | 8.16 273 | 860   | 1.83 727 | 0.99 995 | 10 |
| 3060 | 51 | 8.17 128 | 843   | 3.53 629 | 3.53 624 | 8.17 133 | 843   | 1.82 867 | 0.99 995 | 9  |
| 3120 | 52 | 8.17 971 | 827   | 3.53 629 | 3.53 624 | 8.17 976 | 828   | 1.82 024 | 0.99 995 | 8  |
| 3180 | 53 | 8.18 798 | 812   | 3.53 629 | 3.53 624 | 8.18 804 | 812   | 1.81 196 | 0.99 995 | 7  |
| 3240 | 54 | 8.19 610 | 797   | 3.53 629 | 3.53 624 | 8.19 616 | 797   | 1.80 384 | 0.99 995 | 6  |
| 3300 | 55 | 8.20 407 | 782   | 3.53 629 | 3.53 624 | 8.20 413 | 782   | 1.79 587 | 0.99 994 | 5  |
| 3360 | 56 | 8.21 189 | 769   | 3.53 629 | 3.53 624 | 8.21 195 | 769   | 1.78 805 | 0.99 994 | 4  |
| 3420 | 57 | 8.21 958 | 755   | 3.53 629 | 3.53 623 | 8.21 964 | 756   | 1.78 036 | 0.99 994 | 3  |
| 3480 | 58 | 8.22 713 | 743   | 3.53 629 | 3.53 623 | 8.22 720 | 742   | 1.77 280 | 0.99 994 | 2  |
| 3540 | 59 | 8.23 456 | 730   | 3.53 630 | 3.53 623 | 8.23 462 | 730   | 1.76 538 | 0.99 994 | 1  |
| 3600 | 60 | 8.24 186 |       | 3.53 630 | 3.53 623 | 8.24 192 |       | 1.75 808 | 0.99 993 | 0  |
|      |    | L. Cos.  | d.    |          |          | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | '  |

| "    | '  | L. Sin.  | d.  | Cpl. S'. | Cpl. T'. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  |    |
|------|----|----------|-----|----------|----------|----------|-------|----------|----------|----|
| 3600 | 0  | 8.24 186 |     | 3.53 630 | 3.53 623 | 8.24 192 |       | 1.75 808 | 9.99 993 | 60 |
| 3660 | 1  | 8.24 903 | 717 | 3.53 630 | 3.53 623 | 8.24 910 | 718   | 1.75 090 | 9.99 993 | 59 |
| 3720 | 2  | 8.25 609 | 706 | 3.53 630 | 3.53 623 | 8.25 616 | 706   | 1.74 384 | 9.99 993 | 58 |
| 3780 | 3  | 8.26 304 | 695 | 3.53 630 | 3.53 623 | 8.26 312 | 696   | 1.73 688 | 9.99 993 | 57 |
| 3840 | 4  | 8.26 988 | 684 | 3.53 630 | 3.53 622 | 8.26 996 | 684   | 1.73 004 | 9.99 992 | 56 |
| 3900 | 5  | 8.27 661 | 673 | 3.53 630 | 3.53 622 | 8.27 669 | 673   | 1.72 331 | 9.99 992 | 55 |
| 3960 | 6  | 8.28 324 | 663 | 3.53 630 | 3.53 622 | 8.28 332 | 663   | 1.71 668 | 9.99 992 | 54 |
| 4020 | 7  | 8.28 977 | 653 | 3.53 630 | 3.53 622 | 8.28 986 | 654   | 1.71 014 | 9.99 992 | 53 |
| 4080 | 8  | 8.29 621 | 644 | 3.53 630 | 3.53 622 | 8.29 629 | 643   | 1.70 371 | 9.99 992 | 52 |
| 4140 | 9  | 8.30 253 | 634 | 3.53 630 | 3.53 622 | 8.30 263 | 634   | 1.69 737 | 9.99 991 | 51 |
| 4200 | 10 | 8.30 879 | 624 | 3.53 630 | 3.53 621 | 8.30 888 | 625   | 1.69 112 | 9.99 991 | 50 |
| 4260 | 11 | 8.31 495 | 616 | 3.53 630 | 3.53 621 | 8.31 505 | 617   | 1.68 495 | 9.99 991 | 49 |
| 4320 | 12 | 8.32 103 | 608 | 3.53 631 | 3.53 621 | 8.32 112 | 607   | 1.67 888 | 9.99 990 | 48 |
| 4380 | 13 | 8.32 702 | 599 | 3.53 631 | 3.53 621 | 8.32 711 | 599   | 1.67 289 | 9.99 990 | 47 |
| 4440 | 14 | 8.33 292 | 590 | 3.53 631 | 3.53 621 | 8.33 302 | 591   | 1.66 698 | 9.99 990 | 46 |
| 4500 | 15 | 8.33 875 | 583 | 3.53 631 | 3.53 620 | 8.33 886 | 584   | 1.66 114 | 9.99 990 | 45 |
| 4560 | 16 | 8.34 450 | 575 | 3.53 631 | 3.53 620 | 8.34 461 | 575   | 1.65 539 | 9.99 989 | 44 |
| 4620 | 17 | 8.35 018 | 568 | 3.53 631 | 3.53 620 | 8.35 029 | 568   | 1.64 971 | 9.99 989 | 43 |
| 4680 | 18 | 8.35 578 | 560 | 3.53 631 | 3.53 620 | 8.35 590 | 561   | 1.64 410 | 9.99 989 | 42 |
| 4740 | 19 | 8.36 131 | 553 | 3.53 631 | 3.53 620 | 8.36 143 | 553   | 1.63 857 | 9.99 989 | 41 |
| 4800 | 20 | 8.36 678 | 547 | 3.53 631 | 3.53 620 | 8.36 689 | 546   | 1.63 311 | 9.99 988 | 40 |
| 4860 | 21 | 8.37 217 | 539 | 3.53 631 | 3.53 619 | 8.37 229 | 540   | 1.62 771 | 9.99 988 | 39 |
| 4920 | 22 | 8.37 750 | 533 | 3.53 632 | 3.53 619 | 8.37 762 | 533   | 1.62 238 | 9.99 988 | 38 |
| 4980 | 23 | 8.38 276 | 526 | 3.53 632 | 3.53 619 | 8.38 289 | 527   | 1.61 711 | 9.99 987 | 37 |
| 5040 | 24 | 8.38 796 | 520 | 3.53 632 | 3.53 619 | 8.38 809 | 520   | 1.61 191 | 9.99 987 | 36 |
| 5100 | 25 | 8.39 310 | 514 | 3.53 632 | 3.53 619 | 8.39 323 | 514   | 1.60 677 | 9.99 987 | 35 |
| 5160 | 26 | 8.39 818 | 508 | 3.53 632 | 3.53 618 | 8.39 832 | 509   | 1.60 168 | 9.99 986 | 34 |
| 5220 | 27 | 8.40 320 | 502 | 3.53 632 | 3.53 618 | 8.40 334 | 502   | 1.59 666 | 9.99 986 | 33 |
| 5280 | 28 | 8.40 816 | 496 | 3.53 632 | 3.53 618 | 8.40 830 | 496   | 1.59 159 | 9.99 986 | 32 |
| 5340 | 29 | 8.41 307 | 491 | 3.53 632 | 3.53 618 | 8.41 321 | 491   | 1.58 679 | 9.99 985 | 31 |
| 5400 | 30 | 8.41 792 | 480 | 3.53 632 | 3.53 617 | 8.41 807 | 486   | 1.58 193 | 9.99 985 | 30 |
| 5460 | 31 | 8.42 272 | 474 | 3.53 632 | 3.53 617 | 8.42 287 | 480   | 1.57 713 | 9.99 985 | 29 |
| 5520 | 32 | 8.42 746 | 470 | 3.53 633 | 3.53 617 | 8.42 762 | 475   | 1.57 238 | 9.99 984 | 28 |
| 5580 | 33 | 8.43 216 | 464 | 3.53 633 | 3.53 617 | 8.43 232 | 470   | 1.56 768 | 9.99 984 | 27 |
| 5640 | 34 | 8.43 680 | 464 | 3.53 633 | 3.53 617 | 8.43 696 | 464   | 1.56 304 | 9.99 984 | 26 |
| 5700 | 35 | 8.44 139 | 459 | 3.53 633 | 3.53 616 | 8.44 156 | 460   | 1.55 844 | 9.99 983 | 25 |
| 5760 | 36 | 8.44 594 | 455 | 3.53 633 | 3.53 616 | 8.44 611 | 455   | 1.55 389 | 9.99 983 | 24 |
| 5820 | 37 | 8.45 044 | 450 | 3.53 633 | 3.53 616 | 8.45 061 | 450   | 1.54 939 | 9.99 983 | 23 |
| 5880 | 38 | 8.45 489 | 445 | 3.53 633 | 3.53 616 | 8.45 507 | 446   | 1.54 493 | 9.99 982 | 22 |
| 5940 | 39 | 8.45 930 | 441 | 3.53 633 | 3.53 615 | 8.45 948 | 441   | 1.54 052 | 9.99 982 | 21 |
| 6000 | 40 | 8.46 366 | 436 | 3.53 634 | 3.53 615 | 8.46 385 | 437   | 1.53 615 | 9.99 982 | 20 |
| 6060 | 41 | 8.46 799 | 433 | 3.53 634 | 3.53 615 | 8.46 817 | 432   | 1.53 183 | 9.99 981 | 19 |
| 6120 | 42 | 8.47 226 | 427 | 3.53 634 | 3.53 615 | 8.47 245 | 428   | 1.52 753 | 9.99 981 | 18 |
| 6180 | 43 | 8.47 650 | 424 | 3.53 634 | 3.53 614 | 8.47 669 | 424   | 1.52 331 | 9.99 981 | 17 |
| 6240 | 44 | 8.48 069 | 419 | 3.53 634 | 3.53 614 | 8.48 089 | 420   | 1.51 911 | 9.99 980 | 16 |
| 6300 | 45 | 8.48 485 | 416 | 3.53 634 | 3.53 614 | 8.48 505 | 416   | 1.51 493 | 9.99 980 | 15 |
| 6360 | 46 | 8.48 896 | 411 | 3.53 634 | 3.53 614 | 8.48 917 | 412   | 1.51 083 | 9.99 979 | 14 |
| 6420 | 47 | 8.49 304 | 408 | 3.53 634 | 3.53 613 | 8.49 325 | 408   | 1.50 675 | 9.99 979 | 13 |
| 6480 | 48 | 8.49 708 | 404 | 3.53 635 | 3.53 613 | 8.49 729 | 404   | 1.50 271 | 9.99 979 | 12 |
| 6540 | 49 | 8.50 108 | 400 | 3.53 635 | 3.53 613 | 8.50 130 | 401   | 1.49 870 | 9.99 978 | 11 |
| 6600 | 50 | 8.50 504 | 396 | 3.53 635 | 3.53 613 | 8.50 527 | 397   | 1.49 473 | 9.99 978 | 10 |
| 6660 | 51 | 8.50 897 | 393 | 3.53 635 | 3.53 612 | 8.50 920 | 393   | 1.49 080 | 9.99 977 | 9  |
| 6720 | 52 | 8.51 287 | 390 | 3.53 635 | 3.53 612 | 8.51 310 | 390   | 1.48 690 | 9.99 977 | 8  |
| 6780 | 53 | 8.51 673 | 386 | 3.53 635 | 3.53 612 | 8.51 696 | 386   | 1.48 304 | 9.99 977 | 7  |
| 6840 | 54 | 8.52 055 | 382 | 3.53 635 | 3.53 611 | 8.52 079 | 383   | 1.47 921 | 9.99 976 | 6  |
| 6900 | 55 | 8.52 434 | 379 | 3.53 635 | 3.53 611 | 8.52 459 | 380   | 1.47 541 | 9.99 976 | 5  |
| 6960 | 56 | 8.52 810 | 376 | 3.53 636 | 3.53 611 | 8.52 835 | 376   | 1.47 165 | 9.99 975 | 4  |
| 7020 | 57 | 8.53 183 | 373 | 3.53 636 | 3.53 611 | 8.53 208 | 373   | 1.46 792 | 9.99 975 | 3  |
| 7080 | 58 | 8.53 552 | 369 | 3.53 636 | 3.53 610 | 8.53 578 | 370   | 1.46 422 | 9.99 974 | 2  |
| 7140 | 59 | 8.53 919 | 367 | 3.53 636 | 3.53 610 | 8.53 945 | 367   | 1.46 055 | 9.99 974 | 1  |
| 7200 | 60 | 8.54 282 | 363 | 3.53 636 | 3.53 610 | 8.54 308 | 363   | 1.45 692 | 9.99 974 | 0  |
|      |    | L. Cos.  | d.  |          |          | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | '  |



| "     | '  | L. Sin.  | d.  | Cpl. S'  | Cpl. T'  | L. Tan.  | c. d. | L. Cot.  | L. Cos.  |    |
|-------|----|----------|-----|----------|----------|----------|-------|----------|----------|----|
| 7200  | 0  | 8.54 282 | 360 | 3.53 636 | 3.53 610 | 8.54 308 | 361   | 1.45 692 | 9.99 974 | 60 |
| 7200  | 1  | 8.54 642 | 357 | 3.53 636 | 3.53 609 | 8.54 669 | 358   | 1.45 331 | 9.99 973 | 59 |
| 7230  | 2  | 8.54 999 | 355 | 3.53 637 | 3.53 609 | 8.55 027 | 355   | 1.44 973 | 9.99 973 | 58 |
| 7300  | 3  | 8.55 354 | 351 | 3.53 637 | 3.53 609 | 8.55 382 | 352   | 1.44 618 | 9.99 972 | 57 |
| 7440  | 4  | 8.55 705 | 349 | 3.53 637 | 3.53 609 | 8.55 734 | 349   | 1.44 266 | 9.99 972 | 56 |
| 7500  | 5  | 8.56 054 | 346 | 3.53 637 | 3.53 608 | 8.56 083 | 346   | 1.43 917 | 9.99 971 | 55 |
| 7560  | 6  | 8.56 400 | 343 | 3.53 637 | 3.53 608 | 8.56 429 | 344   | 1.43 571 | 9.99 971 | 54 |
| 7600  | 7  | 8.56 743 | 341 | 3.53 637 | 3.53 608 | 8.56 773 | 341   | 1.43 227 | 9.99 970 | 53 |
| 7680  | 8  | 8.57 084 | 337 | 3.53 637 | 3.53 607 | 8.57 114 | 338   | 1.42 886 | 9.99 970 | 52 |
| 7740  | 9  | 8.57 421 | 336 | 3.53 638 | 3.53 607 | 8.57 452 | 336   | 1.42 548 | 9.99 969 | 51 |
| 7800  | 10 | 8.57 757 | 332 | 3.53 638 | 3.53 607 | 8.57 788 | 333   | 1.42 212 | 9.99 969 | 50 |
| 7860  | 11 | 8.58 089 | 330 | 3.53 638 | 3.53 606 | 8.58 121 | 330   | 1.41 879 | 9.99 968 | 49 |
| 7920  | 12 | 8.58 419 | 328 | 3.53 638 | 3.53 606 | 8.58 451 | 328   | 1.41 549 | 9.99 968 | 48 |
| 7980  | 13 | 8.58 747 | 325 | 3.53 638 | 3.53 606 | 8.58 779 | 326   | 1.41 221 | 9.99 967 | 47 |
| 8040  | 14 | 8.59 072 | 323 | 3.53 638 | 3.53 605 | 8.59 105 | 323   | 1.40 895 | 9.99 967 | 46 |
| 8100  | 15 | 8.59 395 | 320 | 3.53 639 | 3.53 605 | 8.59 428 | 321   | 1.40 572 | 9.99 967 | 45 |
| 8160  | 16 | 8.59 715 | 318 | 3.53 639 | 3.53 605 | 8.59 749 | 319   | 1.40 251 | 9.99 966 | 44 |
| 8220  | 17 | 8.60 033 | 316 | 3.53 639 | 3.53 604 | 8.60 068 | 316   | 1.39 932 | 9.99 966 | 43 |
| 8280  | 18 | 8.60 349 | 313 | 3.53 639 | 3.53 604 | 8.60 384 | 314   | 1.39 616 | 9.99 965 | 42 |
| 8340  | 19 | 8.60 662 | 311 | 3.53 639 | 3.53 604 | 8.60 698 | 311   | 1.39 302 | 9.99 964 | 41 |
| 8400  | 20 | 8.60 973 | 309 | 3.53 639 | 3.53 603 | 8.61 009 | 310   | 1.38 991 | 9.99 964 | 40 |
| 8460  | 21 | 8.61 282 | 307 | 3.53 640 | 3.53 603 | 8.61 319 | 307   | 1.38 681 | 9.99 963 | 39 |
| 8520  | 22 | 8.61 589 | 305 | 3.53 640 | 3.53 603 | 8.61 626 | 305   | 1.38 374 | 9.99 963 | 38 |
| 8580  | 23 | 8.61 894 | 302 | 3.53 640 | 3.53 602 | 8.61 931 | 303   | 1.38 069 | 9.99 962 | 37 |
| 8640  | 24 | 8.62 196 | 301 | 3.53 640 | 3.53 602 | 8.62 234 | 301   | 1.37 766 | 9.99 962 | 36 |
| 8700  | 25 | 8.62 497 | 298 | 3.53 640 | 3.53 602 | 8.62 535 | 299   | 1.37 465 | 9.99 961 | 35 |
| 8760  | 26 | 8.62 795 | 296 | 3.53 640 | 3.53 601 | 8.62 834 | 297   | 1.37 166 | 9.99 961 | 34 |
| 8820  | 27 | 8.63 091 | 294 | 3.53 641 | 3.53 601 | 8.63 131 | 295   | 1.36 869 | 9.99 960 | 33 |
| 8880  | 28 | 8.63 385 | 293 | 3.53 641 | 3.53 601 | 8.63 426 | 292   | 1.36 574 | 9.99 960 | 32 |
| 8940  | 29 | 8.63 678 | 290 | 3.53 641 | 3.53 600 | 8.63 718 | 291   | 1.36 282 | 9.99 959 | 31 |
| 9000  | 30 | 8.63 968 | 288 | 3.53 641 | 3.53 600 | 8.64 009 | 289   | 1.35 991 | 9.99 959 | 30 |
| 9060  | 31 | 8.64 256 | 287 | 3.53 641 | 3.53 599 | 8.64 298 | 287   | 1.35 702 | 9.99 958 | 29 |
| 9120  | 32 | 8.64 543 | 284 | 3.53 642 | 3.53 599 | 8.64 585 | 285   | 1.35 415 | 9.99 958 | 28 |
| 9180  | 33 | 8.64 827 | 283 | 3.53 642 | 3.53 599 | 8.64 870 | 284   | 1.35 130 | 9.99 957 | 27 |
| 9240  | 34 | 8.65 110 | 281 | 3.53 642 | 3.53 598 | 8.65 154 | 281   | 1.34 846 | 9.99 956 | 26 |
| 9300  | 35 | 8.65 391 | 279 | 3.53 642 | 3.53 598 | 8.65 435 | 280   | 1.34 565 | 9.99 956 | 25 |
| 9360  | 36 | 8.65 670 | 277 | 3.53 642 | 3.53 598 | 8.65 715 | 278   | 1.34 285 | 9.99 955 | 24 |
| 9420  | 37 | 8.65 947 | 276 | 3.53 642 | 3.53 597 | 8.65 993 | 276   | 1.34 007 | 9.99 955 | 23 |
| 9480  | 38 | 8.66 223 | 274 | 3.53 643 | 3.53 597 | 8.66 269 | 274   | 1.33 731 | 9.99 954 | 22 |
| 9540  | 39 | 8.66 497 | 272 | 3.53 643 | 3.53 596 | 8.66 543 | 273   | 1.33 457 | 9.99 954 | 21 |
| 9600  | 40 | 8.66 769 | 270 | 3.53 643 | 3.53 596 | 8.66 816 | 271   | 1.33 184 | 9.99 953 | 20 |
| 9660  | 41 | 8.67 039 | 269 | 3.53 643 | 3.53 595 | 8.67 087 | 269   | 1.32 913 | 9.99 952 | 19 |
| 9720  | 42 | 8.67 308 | 267 | 3.53 644 | 3.53 595 | 8.67 356 | 268   | 1.32 644 | 9.99 952 | 18 |
| 9780  | 43 | 8.67 575 | 266 | 3.53 644 | 3.53 595 | 8.67 624 | 266   | 1.32 376 | 9.99 951 | 17 |
| 9840  | 44 | 8.67 841 | 263 | 3.53 644 | 3.53 594 | 8.67 890 | 264   | 1.32 110 | 9.99 951 | 16 |
| 9900  | 45 | 8.68 104 | 263 | 3.53 644 | 3.53 594 | 8.68 154 | 263   | 1.31 846 | 9.99 950 | 15 |
| 9960  | 46 | 8.68 367 | 260 | 3.53 644 | 3.53 594 | 8.68 417 | 261   | 1.31 583 | 9.99 949 | 14 |
| 10020 | 47 | 8.68 627 | 259 | 3.53 645 | 3.53 593 | 8.68 678 | 260   | 1.31 322 | 9.99 949 | 13 |
| 10080 | 48 | 8.68 886 | 258 | 3.53 645 | 3.53 593 | 8.68 938 | 258   | 1.31 062 | 9.99 948 | 12 |
| 10140 | 49 | 8.69 144 | 256 | 3.53 645 | 3.53 592 | 8.69 196 | 257   | 1.30 804 | 9.99 948 | 11 |
| 10200 | 50 | 8.69 400 | 254 | 3.53 645 | 3.53 592 | 8.69 453 | 255   | 1.30 547 | 9.99 947 | 10 |
| 10260 | 51 | 8.69 654 | 253 | 3.53 646 | 3.53 591 | 8.69 708 | 254   | 1.30 292 | 9.99 946 | 9  |
| 10320 | 52 | 8.69 907 | 252 | 3.53 646 | 3.53 591 | 8.69 962 | 252   | 1.30 038 | 9.99 946 | 8  |
| 10380 | 53 | 8.70 159 | 250 | 3.53 646 | 3.53 590 | 8.70 214 | 251   | 1.29 786 | 9.99 945 | 7  |
| 10440 | 54 | 8.70 409 | 249 | 3.53 646 | 3.53 590 | 8.70 465 | 249   | 1.29 535 | 9.99 944 | 6  |
| 10500 | 55 | 8.70 658 | 247 | 3.53 646 | 3.53 589 | 8.70 714 | 248   | 1.29 286 | 9.99 944 | 5  |
| 10560 | 56 | 8.70 905 | 246 | 3.53 647 | 3.53 589 | 8.70 962 | 246   | 1.29 038 | 9.99 943 | 4  |
| 10620 | 57 | 8.71 151 | 244 | 3.53 647 | 3.53 588 | 8.71 208 | 245   | 1.28 792 | 9.99 942 | 3  |
| 10680 | 58 | 8.71 395 | 243 | 3.53 647 | 3.53 588 | 8.71 453 | 244   | 1.28 547 | 9.99 942 | 2  |
| 10740 | 59 | 8.71 638 | 242 | 3.53 647 | 3.53 588 | 8.71 697 | 243   | 1.28 303 | 9.99 941 | 1  |
| 10800 | 60 | 8.71 880 |     | 3.53 647 | 3.53 588 | 8.71 940 |       | 1.28 060 | 9.99 940 | 0  |
|       |    | L. Cos.  | d.  |          |          | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | '  |

|    | L. Sin.  | d.  | L. Tan.  | c.d.  | L. Cot.  | L. Cos.  | P. P. |
|----|----------|-----|----------|-------|----------|----------|-------|
| 0  | 8.71 880 | 240 | 8.71 940 | 241   | 1.28 060 | 9.99 940 | 60    |
| 1  | 8.72 120 | 239 | 8.72 181 | 241   | 1.27 819 | 9.99 940 | 59    |
| 2  | 8.72 359 | 238 | 8.72 420 | 239   | 1.27 580 | 9.99 939 | 58    |
| 3  | 8.72 597 | 237 | 8.72 659 | 239   | 1.27 341 | 9.99 938 | 57    |
| 4  | 8.72 834 | 237 | 8.72 896 | 237   | 1.27 104 | 9.99 938 | 56    |
| 5  | 8.73 069 | 235 | 8.73 132 | 236   | 1.26 868 | 9.99 937 | 55    |
| 6  | 8.73 303 | 234 | 8.73 366 | 234   | 1.26 634 | 9.99 936 | 54    |
| 7  | 8.73 535 | 232 | 8.73 600 | 234   | 1.26 400 | 9.99 936 | 53    |
| 8  | 8.73 767 | 232 | 8.73 832 | 232   | 1.26 168 | 9.99 935 | 52    |
| 9  | 8.73 997 | 230 | 8.74 063 | 231   | 1.25 937 | 9.99 934 | 51    |
| 10 | 8.74 226 | 229 | 8.74 292 | 229   | 1.25 708 | 9.99 934 | 50    |
| 11 | 8.74 454 | 228 | 8.74 521 | 227   | 1.25 479 | 9.99 933 | 49    |
| 12 | 8.74 680 | 226 | 8.74 748 | 226   | 1.25 252 | 9.99 932 | 48    |
| 13 | 8.74 906 | 226 | 8.74 974 | 226   | 1.25 026 | 9.99 932 | 47    |
| 14 | 8.75 130 | 224 | 8.75 199 | 225   | 1.24 801 | 9.99 931 | 46    |
| 15 | 8.75 353 | 223 | 8.75 423 | 224   | 1.24 577 | 9.99 930 | 45    |
| 16 | 8.75 575 | 222 | 8.75 645 | 222   | 1.24 355 | 9.99 929 | 44    |
| 17 | 8.75 795 | 220 | 8.75 867 | 222   | 1.24 133 | 9.99 929 | 43    |
| 18 | 8.76 015 | 219 | 8.76 087 | 220   | 1.23 913 | 9.99 928 | 42    |
| 19 | 8.76 234 | 217 | 8.76 306 | 219   | 1.23 694 | 9.99 927 | 41    |
| 20 | 8.76 451 | 216 | 8.76 525 | 217   | 1.23 475 | 9.99 926 | 40    |
| 21 | 8.76 667 | 216 | 8.76 742 | 216   | 1.23 258 | 9.99 926 | 39    |
| 22 | 8.76 883 | 214 | 8.76 958 | 215   | 1.23 042 | 9.99 925 | 38    |
| 23 | 8.77 097 | 213 | 8.77 173 | 214   | 1.22 827 | 9.99 924 | 37    |
| 24 | 8.77 310 | 212 | 8.77 387 | 213   | 1.22 613 | 9.99 923 | 36    |
| 25 | 8.77 522 | 211 | 8.77 600 | 211   | 1.22 400 | 9.99 923 | 35    |
| 26 | 8.77 733 | 210 | 8.77 811 | 211   | 1.22 189 | 9.99 922 | 34    |
| 27 | 8.77 943 | 209 | 8.78 022 | 210   | 1.21 978 | 9.99 921 | 33    |
| 28 | 8.78 152 | 208 | 8.78 232 | 209   | 1.21 768 | 9.99 920 | 32    |
| 29 | 8.78 360 | 208 | 8.78 441 | 208   | 1.21 559 | 9.99 920 | 31    |
| 30 | 8.78 568 | 206 | 8.78 649 | 206   | 1.21 351 | 9.99 919 | 30    |
| 31 | 8.78 774 | 205 | 8.78 855 | 206   | 1.21 145 | 9.99 918 | 29    |
| 32 | 8.78 979 | 204 | 8.79 061 | 205   | 1.20 939 | 9.99 917 | 28    |
| 33 | 8.79 183 | 203 | 8.79 266 | 204   | 1.20 734 | 9.99 917 | 27    |
| 34 | 8.79 386 | 202 | 8.79 470 | 203   | 1.20 530 | 9.99 916 | 26    |
| 35 | 8.79 588 | 201 | 8.79 673 | 202   | 1.20 327 | 9.99 915 | 25    |
| 36 | 8.79 789 | 201 | 8.79 875 | 201   | 1.20 125 | 9.99 914 | 24    |
| 37 | 8.79 990 | 199 | 8.80 076 | 201   | 1.19 924 | 9.99 913 | 23    |
| 38 | 8.80 189 | 199 | 8.80 277 | 199   | 1.19 723 | 9.99 913 | 22    |
| 39 | 8.80 388 | 197 | 8.80 476 | 198   | 1.19 524 | 9.99 912 | 21    |
| 40 | 8.80 585 | 197 | 8.80 674 | 198   | 1.19 326 | 9.99 911 | 20    |
| 41 | 8.80 782 | 196 | 8.80 872 | 196   | 1.19 128 | 9.99 910 | 19    |
| 42 | 8.80 978 | 195 | 8.81 068 | 196   | 1.18 932 | 9.99 909 | 18    |
| 43 | 8.81 173 | 194 | 8.81 264 | 195   | 1.18 736 | 9.99 909 | 17    |
| 44 | 8.81 367 | 193 | 8.81 459 | 194   | 1.18 541 | 9.99 908 | 16    |
| 45 | 8.81 560 | 192 | 8.81 653 | 193   | 1.18 347 | 9.99 907 | 15    |
| 46 | 8.81 752 | 192 | 8.81 846 | 192   | 1.18 154 | 9.99 906 | 14    |
| 47 | 8.81 944 | 190 | 8.82 038 | 192   | 1.17 962 | 9.99 905 | 13    |
| 48 | 8.82 134 | 190 | 8.82 230 | 190   | 1.17 770 | 9.99 904 | 12    |
| 49 | 8.82 324 | 189 | 8.82 420 | 190   | 1.17 580 | 9.99 904 | 11    |
| 50 | 8.82 513 | 188 | 8.82 610 | 189   | 1.17 390 | 9.99 903 | 10    |
| 51 | 8.82 701 | 187 | 8.82 799 | 188   | 1.17 201 | 9.99 902 | 9     |
| 52 | 8.82 888 | 187 | 8.82 987 | 188   | 1.17 013 | 9.99 901 | 8     |
| 53 | 8.83 075 | 186 | 8.83 175 | 186   | 1.16 825 | 9.99 900 | 7     |
| 54 | 8.83 261 | 185 | 8.83 361 | 186   | 1.16 639 | 9.99 899 | 6     |
| 55 | 8.83 446 | 184 | 8.83 547 | 185   | 1.16 453 | 9.99 898 | 5     |
| 56 | 8.83 630 | 183 | 8.83 732 | 184   | 1.16 268 | 9.99 898 | 4     |
| 57 | 8.83 813 | 183 | 8.83 916 | 184   | 1.16 084 | 9.99 897 | 3     |
| 58 | 8.83 996 | 181 | 8.84 100 | 182   | 1.15 900 | 9.99 896 | 2     |
| 59 | 8.84 177 | 181 | 8.84 282 | 182   | 1.15 718 | 9.99 895 | 1     |
| 60 | 8.84 358 | 181 | 8.84 464 | 182   | 1.15 536 | 9.99 894 | 0     |
|    | L. Cos.  | d.  | L. Cot.  | c. d. | L. Sin.  |          | P. P. |

|    | L. Sin.  | d.  | L. Tan.  | c.d.  | L. Cot.  | L. Cos.  | P. P. |
|----|----------|-----|----------|-------|----------|----------|-------|
| 0  | 8.84 358 |     | 8.84 464 |       | 1.15 536 | 9.99 894 | 60    |
| 1  | 8.84 539 | 181 | 8.84 646 | 182   | 1.15 354 | 9.99 893 | 59    |
| 2  | 8.84 718 | 179 | 8.84 826 | 180   | 1.15 174 | 9.99 892 | 58    |
| 3  | 8.84 897 | 177 | 8.85 006 | 179   | 1.14 994 | 9.99 891 | 57    |
| 4  | 8.85 075 | 178 | 8.85 185 | 178   | 1.14 815 | 9.99 890 | 56    |
| 5  | 8.85 252 | 177 | 8.85 363 | 177   | 1.14 637 | 9.99 889 | 55    |
| 6  | 8.85 429 | 175 | 8.85 540 | 177   | 1.14 460 | 9.99 888 | 54    |
| 7  | 8.85 605 | 176 | 8.85 717 | 176   | 1.14 283 | 9.99 887 | 53    |
| 8  | 8.85 780 | 175 | 8.85 893 | 176   | 1.14 107 | 9.99 886 | 52    |
| 9  | 8.85 955 | 173 | 8.86 069 | 174   | 1.13 931 | 9.99 885 | 51    |
| 10 | 8.86 128 | 173 | 8.86 243 | 174   | 1.13 757 | 9.99 884 | 50    |
| 11 | 8.86 301 | 173 | 8.86 417 | 174   | 1.13 583 | 9.99 883 | 49    |
| 12 | 8.86 474 | 171 | 8.86 591 | 172   | 1.13 409 | 9.99 882 | 48    |
| 13 | 8.86 645 | 171 | 8.86 763 | 172   | 1.13 237 | 9.99 881 | 47    |
| 14 | 8.86 816 | 171 | 8.86 935 | 171   | 1.13 065 | 9.99 880 | 46    |
| 15 | 8.86 987 | 169 | 8.87 106 | 171   | 1.12 894 | 9.99 879 | 45    |
| 16 | 8.87 156 | 169 | 8.87 277 | 170   | 1.12 723 | 9.99 878 | 44    |
| 17 | 8.87 325 | 169 | 8.87 447 | 169   | 1.12 553 | 9.99 877 | 43    |
| 18 | 8.87 494 | 167 | 8.87 616 | 169   | 1.12 384 | 9.99 876 | 42    |
| 19 | 8.87 661 | 168 | 8.87 785 | 168   | 1.12 215 | 9.99 875 | 41    |
| 20 | 8.87 829 | 166 | 8.87 953 | 167   | 1.12 047 | 9.99 874 | 40    |
| 21 | 8.87 995 | 166 | 8.88 120 | 167   | 1.11 880 | 9.99 873 | 39    |
| 22 | 8.88 161 | 165 | 8.88 287 | 166   | 1.11 713 | 9.99 872 | 38    |
| 23 | 8.88 326 | 164 | 8.88 453 | 165   | 1.11 547 | 9.99 871 | 37    |
| 24 | 8.88 490 | 164 | 8.88 618 | 165   | 1.11 382 | 9.99 870 | 36    |
| 25 | 8.88 654 | 163 | 8.88 783 | 165   | 1.11 217 | 9.99 869 | 35    |
| 26 | 8.88 817 | 163 | 8.88 948 | 163   | 1.11 052 | 9.99 868 | 34    |
| 27 | 8.88 980 | 162 | 8.89 111 | 163   | 1.10 889 | 9.99 867 | 33    |
| 28 | 8.89 142 | 162 | 8.89 274 | 163   | 1.10 726 | 9.99 866 | 32    |
| 29 | 8.89 304 | 160 | 8.89 437 | 161   | 1.10 563 | 9.99 865 | 31    |
| 30 | 8.89 464 | 161 | 8.89 598 | 162   | 1.10 402 | 9.99 864 | 30    |
| 31 | 8.89 625 | 159 | 8.89 760 | 160   | 1.10 240 | 9.99 863 | 29    |
| 32 | 8.89 784 | 159 | 8.89 920 | 160   | 1.10 080 | 9.99 862 | 28    |
| 33 | 8.89 943 | 159 | 8.90 080 | 160   | 1.09 920 | 9.99 861 | 27    |
| 34 | 8.90 102 | 158 | 8.90 240 | 159   | 1.09 760 | 9.99 860 | 26    |
| 35 | 8.90 260 | 157 | 8.90 399 | 158   | 1.09 601 | 9.99 859 | 25    |
| 36 | 8.90 417 | 157 | 8.90 557 | 158   | 1.09 443 | 9.99 858 | 24    |
| 37 | 8.90 574 | 156 | 8.90 715 | 157   | 1.09 285 | 9.99 857 | 23    |
| 38 | 8.90 730 | 155 | 8.90 872 | 157   | 1.09 128 | 9.99 856 | 22    |
| 39 | 8.90 885 | 155 | 8.91 029 | 156   | 1.08 971 | 9.99 855 | 21    |
| 40 | 8.91 040 | 155 | 8.91 185 | 155   | 1.08 815 | 9.99 854 | 20    |
| 41 | 8.91 195 | 154 | 8.91 340 | 155   | 1.08 660 | 9.99 853 | 19    |
| 42 | 8.91 349 | 153 | 8.91 495 | 155   | 1.08 505 | 9.99 852 | 18    |
| 43 | 8.91 502 | 153 | 8.91 650 | 155   | 1.08 350 | 9.99 851 | 17    |
| 44 | 8.91 655 | 152 | 8.91 803 | 154   | 1.08 197 | 9.99 850 | 16    |
| 45 | 8.91 807 | 152 | 8.91 957 | 153   | 1.08 043 | 9.99 849 | 15    |
| 46 | 8.91 959 | 151 | 8.92 110 | 152   | 1.07 890 | 9.99 848 | 14    |
| 47 | 8.92 110 | 151 | 8.92 262 | 152   | 1.07 738 | 9.99 847 | 13    |
| 48 | 8.92 261 | 150 | 8.92 414 | 151   | 1.07 586 | 9.99 846 | 12    |
| 49 | 8.92 411 | 150 | 8.92 565 | 151   | 1.07 435 | 9.99 845 | 11    |
| 50 | 8.92 561 | 149 | 8.92 716 | 150   | 1.07 284 | 9.99 844 | 10    |
| 51 | 8.92 710 | 149 | 8.92 866 | 150   | 1.07 134 | 9.99 843 | 9     |
| 52 | 8.92 859 | 148 | 8.93 016 | 149   | 1.06 985 | 9.99 842 | 8     |
| 53 | 8.93 007 | 147 | 8.93 165 | 148   | 1.06 835 | 9.99 841 | 7     |
| 54 | 8.93 154 | 147 | 8.93 313 | 149   | 1.06 687 | 9.99 840 | 6     |
| 55 | 8.93 301 | 147 | 8.93 462 | 147   | 1.06 538 | 9.99 839 | 5     |
| 56 | 8.93 448 | 146 | 8.93 609 | 147   | 1.06 391 | 9.99 838 | 4     |
| 57 | 8.93 594 | 146 | 8.93 756 | 147   | 1.06 244 | 9.99 837 | 3     |
| 58 | 8.93 740 | 145 | 8.93 903 | 146   | 1.06 097 | 9.99 836 | 2     |
| 59 | 8.93 885 | 145 | 8.94 049 | 146   | 1.05 951 | 9.99 835 | 1     |
| 60 | 8.94 030 | 145 | 8.94 195 | 146   | 1.05 805 | 9.99 834 | 0     |
|    | L. Cos.  | d.  | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | P. P. |

|    | L. Sin.  | d.  | L. Tan.  | c.d. | L. Cot.  | L. Cos.  |    | P. P. |
|----|----------|-----|----------|------|----------|----------|----|-------|
| 0  | 8.94 030 |     | 8.94 195 | 145  | 1.05 803 | 9.99 834 | 60 |       |
| 1  | 8.94 174 | 144 | 8.94 340 | 145  | 1.05 660 | 9.99 833 | 59 |       |
| 2  | 8.94 317 | 143 | 8.94 485 | 145  | 1.05 515 | 9.99 832 | 58 |       |
| 3  | 8.94 461 | 144 | 8.94 630 | 145  | 1.05 370 | 9.99 831 | 57 |       |
| 4  | 8.94 603 | 142 | 8.94 773 | 144  | 1.05 227 | 9.99 830 | 56 |       |
| 5  | 8.94 746 | 143 | 8.94 917 | 143  | 1.05 083 | 9.99 829 | 55 |       |
| 6  | 8.94 887 | 141 | 8.95 060 | 143  | 1.04 940 | 9.99 828 | 54 |       |
| 7  | 8.95 029 | 142 | 8.95 202 | 142  | 1.04 798 | 9.99 827 | 53 |       |
| 8  | 8.95 170 | 141 | 8.95 344 | 142  | 1.04 656 | 9.99 825 | 52 |       |
| 9  | 8.95 310 | 140 | 8.95 486 | 142  | 1.04 514 | 9.99 824 | 51 |       |
| 10 | 8.95 450 | 140 | 8.95 627 | 141  | 1.04 373 | 9.99 823 | 50 |       |
| 11 | 8.95 589 | 139 | 8.95 767 | 140  | 1.04 233 | 9.99 822 | 49 |       |
| 12 | 8.95 728 | 139 | 8.95 908 | 141  | 1.04 092 | 9.99 821 | 48 |       |
| 13 | 8.95 867 | 139 | 8.96 047 | 139  | 1.03 953 | 9.99 820 | 47 |       |
| 14 | 8.96 005 | 138 | 8.96 187 | 140  | 1.03 813 | 9.99 819 | 46 |       |
| 15 | 8.96 143 | 138 | 8.96 325 | 138  | 1.03 673 | 9.99 817 | 45 |       |
| 16 | 8.96 280 | 137 | 8.96 464 | 139  | 1.03 536 | 9.99 816 | 44 |       |
| 17 | 8.96 417 | 137 | 8.96 602 | 138  | 1.03 398 | 9.99 815 | 43 |       |
| 18 | 8.96 557 | 136 | 8.96 739 | 137  | 1.03 261 | 9.99 814 | 42 |       |
| 19 | 8.96 689 | 136 | 8.96 877 | 138  | 1.03 123 | 9.99 813 | 41 |       |
| 20 | 8.96 823 | 136 | 8.97 013 | 136  | 1.02 987 | 9.99 812 | 40 |       |
| 21 | 8.96 960 | 135 | 8.97 150 | 137  | 1.02 850 | 9.99 810 | 39 |       |
| 22 | 8.97 095 | 135 | 8.97 285 | 135  | 1.02 715 | 9.99 809 | 38 |       |
| 23 | 8.97 229 | 134 | 8.97 421 | 136  | 1.02 579 | 9.99 808 | 37 |       |
| 24 | 8.97 363 | 134 | 8.97 556 | 135  | 1.02 444 | 9.99 807 | 36 |       |
| 25 | 8.97 496 | 133 | 8.97 691 | 135  | 1.02 309 | 9.99 806 | 35 |       |
| 26 | 8.97 629 | 133 | 8.97 823 | 134  | 1.02 175 | 9.99 804 | 34 |       |
| 27 | 8.97 762 | 133 | 8.97 959 | 134  | 1.02 041 | 9.99 803 | 33 |       |
| 28 | 8.97 894 | 132 | 8.98 092 | 133  | 1.01 908 | 9.99 802 | 32 |       |
| 29 | 8.98 026 | 132 | 8.98 225 | 133  | 1.01 775 | 9.99 801 | 31 |       |
| 30 | 8.98 157 | 131 | 8.98 358 | 133  | 1.01 642 | 9.99 800 | 30 |       |
| 31 | 8.98 288 | 131 | 8.98 490 | 132  | 1.01 510 | 9.99 798 | 29 |       |
| 32 | 8.98 419 | 131 | 8.98 622 | 132  | 1.01 378 | 9.99 797 | 28 |       |
| 33 | 8.98 549 | 130 | 8.98 753 | 131  | 1.01 247 | 9.99 796 | 27 |       |
| 34 | 8.98 679 | 130 | 8.98 884 | 131  | 1.01 116 | 9.99 795 | 26 |       |
| 35 | 8.98 808 | 129 | 8.99 015 | 130  | 1.00 985 | 9.99 793 | 25 |       |
| 36 | 8.98 937 | 129 | 8.99 145 | 130  | 1.00 855 | 9.99 792 | 24 |       |
| 37 | 8.99 066 | 129 | 8.99 275 | 130  | 1.00 725 | 9.99 791 | 23 |       |
| 38 | 8.99 194 | 128 | 8.99 405 | 130  | 1.00 595 | 9.99 790 | 22 |       |
| 39 | 8.99 322 | 128 | 8.99 534 | 129  | 1.00 466 | 9.99 788 | 21 |       |
| 40 | 8.99 450 | 128 | 8.99 662 | 128  | 1.00 338 | 9.99 787 | 20 |       |
| 41 | 8.99 577 | 127 | 8.99 791 | 129  | 1.00 209 | 9.99 786 | 19 |       |
| 42 | 8.99 704 | 127 | 8.99 919 | 128  | 1.00 081 | 9.99 785 | 18 |       |
| 43 | 8.99 830 | 126 | 9.00 046 | 127  | 0.99 954 | 9.99 783 | 17 |       |
| 44 | 8.99 956 | 126 | 9.00 174 | 128  | 0.99 826 | 9.99 782 | 16 |       |
| 45 | 9.00 082 | 126 | 9.00 301 | 127  | 0.99 699 | 9.99 781 | 15 |       |
| 46 | 9.00 207 | 125 | 9.00 427 | 126  | 0.99 573 | 9.99 780 | 14 |       |
| 47 | 9.00 332 | 125 | 9.00 553 | 126  | 0.99 447 | 9.99 778 | 13 |       |
| 48 | 9.00 456 | 124 | 9.00 679 | 126  | 0.99 321 | 9.99 777 | 12 |       |
| 49 | 9.00 581 | 125 | 9.00 805 | 125  | 0.99 195 | 9.99 776 | 11 |       |
| 50 | 9.00 704 | 123 | 9.00 930 | 125  | 0.99 070 | 9.99 775 | 10 |       |
| 51 | 9.00 828 | 124 | 9.01 055 | 125  | 0.98 945 | 9.99 773 | 9  |       |
| 52 | 9.00 951 | 123 | 9.01 179 | 124  | 0.98 821 | 9.99 772 | 8  |       |
| 53 | 9.01 074 | 123 | 9.01 303 | 124  | 0.98 697 | 9.99 771 | 7  |       |
| 54 | 9.01 196 | 122 | 9.01 427 | 124  | 0.98 573 | 9.99 769 | 6  |       |
| 55 | 9.01 318 | 122 | 9.01 550 | 123  | 0.98 450 | 9.99 768 | 5  |       |
| 56 | 9.01 440 | 122 | 9.01 673 | 123  | 0.98 327 | 9.99 767 | 4  |       |
| 57 | 9.01 561 | 121 | 9.01 796 | 123  | 0.98 204 | 9.99 765 | 3  |       |
| 58 | 9.01 682 | 121 | 9.01 918 | 122  | 0.98 082 | 9.99 764 | 2  |       |
| 59 | 9.01 803 | 121 | 9.02 040 | 122  | 0.97 960 | 9.99 763 | 1  |       |
| 60 | 9.01 923 | 120 | 9.02 162 | 122  | 0.97 838 | 9.99 761 | 0  |       |
|    | L. Cos.  | d.  | L. Cot.  | c.d. | L. Tan.  | L. Sin.  |    | P. P. |

|    | L. Sin.  | d.  | L. Tan.  | c.d. | L. Cot.  | L. Cos.  | P. P. |
|----|----------|-----|----------|------|----------|----------|-------|
| 0  | 8.84 358 | 181 | 8.84 464 | 182  | 1.15 536 | 9.99 894 | 60    |
| 1  | 8.84 539 | 179 | 8.84 646 | 180  | 1.15 354 | 9.99 893 | 59    |
| 2  | 8.84 718 | 179 | 8.84 826 | 180  | 1.15 174 | 9.99 892 | 58    |
| 3  | 8.84 897 | 178 | 8.85 006 | 179  | 1.14 994 | 9.99 891 | 57    |
| 4  | 8.85 075 | 177 | 8.85 185 | 178  | 1.14 815 | 9.99 891 | 56    |
| 5  | 8.85 252 | 177 | 8.85 363 | 177  | 1.14 637 | 9.99 890 | 55    |
| 6  | 8.85 429 | 176 | 8.85 540 | 177  | 1.14 460 | 9.99 889 | 54    |
| 7  | 8.85 605 | 175 | 8.85 717 | 176  | 1.14 283 | 9.99 888 | 53    |
| 8  | 8.85 780 | 175 | 8.85 893 | 176  | 1.14 107 | 9.99 887 | 52    |
| 9  | 8.85 955 | 173 | 8.86 009 | 174  | 1.13 931 | 9.99 886 | 51    |
| 10 | 8.86 128 | 173 | 8.86 243 | 174  | 1.13 757 | 9.99 885 | 50    |
| 11 | 8.86 301 | 173 | 8.86 417 | 174  | 1.13 583 | 9.99 884 | 49    |
| 12 | 8.86 474 | 171 | 8.86 593 | 172  | 1.13 409 | 9.99 883 | 48    |
| 13 | 8.86 645 | 171 | 8.86 763 | 172  | 1.13 237 | 9.99 882 | 47    |
| 14 | 8.86 816 | 171 | 8.86 935 | 171  | 1.13 065 | 9.99 881 | 46    |
| 15 | 8.86 987 | 169 | 8.87 106 | 171  | 1.12 894 | 9.99 880 | 45    |
| 16 | 8.87 156 | 169 | 8.87 277 | 170  | 1.12 723 | 9.99 879 | 44    |
| 17 | 8.87 325 | 169 | 8.87 447 | 169  | 1.12 553 | 9.99 879 | 43    |
| 18 | 8.87 494 | 167 | 8.87 616 | 169  | 1.12 384 | 9.99 878 | 42    |
| 19 | 8.87 661 | 168 | 8.87 785 | 168  | 1.12 215 | 9.99 877 | 41    |
| 20 | 8.87 829 | 166 | 8.87 953 | 167  | 1.12 047 | 9.99 876 | 40    |
| 21 | 8.87 995 | 166 | 8.88 120 | 167  | 1.11 880 | 9.99 875 | 39    |
| 22 | 8.88 161 | 165 | 8.88 287 | 166  | 1.11 713 | 9.99 874 | 38    |
| 23 | 8.88 326 | 164 | 8.88 453 | 165  | 1.11 547 | 9.99 873 | 37    |
| 24 | 8.88 490 | 164 | 8.88 618 | 165  | 1.11 382 | 9.99 872 | 36    |
| 25 | 8.88 654 | 163 | 8.88 783 | 165  | 1.11 217 | 9.99 871 | 35    |
| 26 | 8.88 817 | 163 | 8.88 943 | 163  | 1.11 052 | 9.99 870 | 34    |
| 27 | 8.88 980 | 162 | 8.89 111 | 163  | 1.10 889 | 9.99 869 | 33    |
| 28 | 8.89 142 | 162 | 8.89 274 | 163  | 1.10 726 | 9.99 868 | 32    |
| 29 | 8.89 304 | 160 | 8.89 437 | 161  | 1.10 563 | 9.99 867 | 31    |
| 30 | 8.89 464 | 161 | 8.89 598 | 162  | 1.10 402 | 9.99 866 | 30    |
| 31 | 8.89 625 | 159 | 8.89 760 | 160  | 1.10 240 | 9.99 865 | 29    |
| 32 | 8.89 784 | 159 | 8.89 920 | 160  | 1.10 080 | 9.99 864 | 28    |
| 33 | 8.89 943 | 159 | 8.90 080 | 160  | 1.09 920 | 9.99 863 | 27    |
| 34 | 8.90 102 | 158 | 8.90 240 | 159  | 1.09 760 | 9.99 862 | 26    |
| 35 | 8.90 260 | 157 | 8.90 399 | 158  | 1.09 601 | 9.99 861 | 25    |
| 36 | 8.90 417 | 157 | 8.90 557 | 158  | 1.09 443 | 9.99 860 | 24    |
| 37 | 8.90 574 | 156 | 8.90 715 | 157  | 1.09 285 | 9.99 859 | 23    |
| 38 | 8.90 730 | 155 | 8.90 872 | 157  | 1.09 128 | 9.99 858 | 22    |
| 39 | 8.90 885 | 155 | 8.91 029 | 156  | 1.08 971 | 9.99 857 | 21    |
| 40 | 8.91 040 | 155 | 8.91 185 | 155  | 1.08 815 | 9.99 856 | 20    |
| 41 | 8.91 195 | 154 | 8.91 340 | 155  | 1.08 660 | 9.99 855 | 19    |
| 42 | 8.91 349 | 153 | 8.91 495 | 155  | 1.08 505 | 9.99 854 | 18    |
| 43 | 8.91 502 | 153 | 8.91 650 | 155  | 1.08 350 | 9.99 853 | 17    |
| 44 | 8.91 655 | 152 | 8.91 803 | 154  | 1.08 197 | 9.99 852 | 16    |
| 45 | 8.91 807 | 152 | 8.91 957 | 153  | 1.08 043 | 9.99 851 | 15    |
| 46 | 8.91 959 | 151 | 8.92 110 | 152  | 1.07 890 | 9.99 850 | 14    |
| 47 | 8.92 110 | 151 | 8.92 262 | 152  | 1.07 738 | 9.99 848 | 13    |
| 48 | 8.92 261 | 150 | 8.92 414 | 151  | 1.07 586 | 9.99 847 | 12    |
| 49 | 8.92 411 | 150 | 8.92 565 | 151  | 1.07 435 | 9.99 846 | 11    |
| 50 | 8.92 561 | 149 | 8.92 716 | 150  | 1.07 284 | 9.99 845 | 10    |
| 51 | 8.92 710 | 149 | 8.92 866 | 150  | 1.07 134 | 9.99 844 | 9     |
| 52 | 8.92 859 | 148 | 8.93 016 | 149  | 1.06 984 | 9.99 843 | 8     |
| 53 | 8.93 007 | 147 | 8.93 165 | 148  | 1.06 835 | 9.99 842 | 7     |
| 54 | 8.93 154 | 147 | 8.93 313 | 149  | 1.06 687 | 9.99 841 | 6     |
| 55 | 8.93 301 | 147 | 8.93 462 | 147  | 1.06 538 | 9.99 840 | 5     |
| 56 | 8.93 448 | 146 | 8.93 609 | 147  | 1.06 391 | 9.99 839 | 4     |
| 57 | 8.93 594 | 146 | 8.93 756 | 147  | 1.06 244 | 9.99 838 | 3     |
| 58 | 8.93 740 | 145 | 8.93 903 | 146  | 1.06 097 | 9.99 837 | 2     |
| 59 | 8.93 885 | 145 | 8.94 049 | 146  | 1.05 951 | 9.99 836 | 1     |
| 60 | 8.94 030 | 145 | 8.94 195 | 146  | 1.05 805 | 9.99 834 | 0     |
|    | L. Cos.  | d.  | L. Cot.  | c.d. | L. Tan.  | L. Sin.  | P. P. |

|    | L. Sin.  | d.    | L. Tan.  | c.d.  | L. Cot.  | L. Cos.  | P. P. |
|----|----------|-------|----------|-------|----------|----------|-------|
| 0  | 8.94 030 |       | 8.94 195 |       | 1.05 805 | 9.99 834 |       |
| 1  | 8.94 174 | 144   | 8.94 340 | 145   | 1.05 660 | 9.99 833 |       |
| 2  | 8.94 317 | 143   | 8.94 485 | 145   | 1.05 515 | 9.99 832 |       |
| 3  | 8.94 461 | 144   | 8.94 630 | 145   | 1.05 370 | 9.99 831 |       |
| 4  | 8.94 603 | 142   | 8.94 773 | 143   | 1.05 227 | 9.99 830 |       |
| 5  | 8.94 746 | 143   | 8.94 917 | 144   | 1.05 083 | 9.99 829 |       |
| 6  | 8.94 887 | 141   | 8.95 060 | 143   | 1.04 940 | 9.99 828 |       |
| 7  | 8.95 029 | 142   | 8.95 202 | 142   | 1.04 798 | 9.99 827 |       |
| 8  | 8.95 170 | 141   | 8.95 344 | 142   | 1.04 656 | 9.99 825 |       |
| 9  | 8.95 310 | 140   | 8.95 486 | 142   | 1.04 514 | 9.99 824 |       |
| 10 | 8.95 450 | 140   | 8.95 627 | 141   | 1.04 373 | 9.99 823 |       |
| 11 | 8.95 589 | 139   | 8.95 767 | 140   | 1.04 233 | 9.99 822 |       |
| 12 | 8.95 728 | 139   | 8.95 908 | 141   | 1.04 092 | 9.99 821 |       |
| 13 | 8.95 867 | 139   | 8.96 047 | 139   | 1.03 953 | 9.99 820 |       |
| 14 | 8.96 005 | 138   | 8.96 187 | 140   | 1.03 813 | 9.99 819 |       |
| 15 | 8.96 143 | 138   | 8.96 325 | 138   | 1.03 675 | 9.99 817 |       |
| 16 | 8.96 280 | 137   | 8.96 464 | 139   | 1.03 536 | 9.99 816 |       |
| 17 | 8.96 417 | 137   | 8.96 602 | 138   | 1.03 398 | 9.99 815 |       |
| 18 | 8.96 553 | 136   | 8.96 739 | 137   | 1.03 261 | 9.99 814 |       |
| 19 | 8.96 689 | 136   | 8.96 877 | 138   | 1.03 123 | 9.99 813 |       |
| 20 | 8.96 825 | 136   | 8.97 013 | 136   | 1.02 987 | 9.99 812 |       |
| 21 | 8.96 960 | 135   | 8.97 150 | 137   | 1.02 850 | 9.99 810 |       |
| 22 | 8.97 095 | 135   | 8.97 285 | 135   | 1.02 715 | 9.99 809 |       |
| 23 | 8.97 229 | 134   | 8.97 421 | 136   | 1.02 579 | 9.99 808 |       |
| 24 | 8.97 363 | 134   | 8.97 556 | 135   | 1.02 444 | 9.99 807 |       |
| 25 | 8.97 496 | 133   | 8.97 691 | 135   | 1.02 309 | 9.99 806 |       |
| 26 | 8.97 629 | 133   | 8.97 825 | 134   | 1.02 175 | 9.99 804 |       |
| 27 | 8.97 762 | 133   | 8.97 959 | 134   | 1.02 041 | 9.99 803 |       |
| 28 | 8.97 894 | 132   | 8.98 092 | 133   | 1.01 908 | 9.99 802 |       |
| 29 | 8.98 026 | 132   | 8.98 225 | 133   | 1.01 775 | 9.99 801 |       |
| 30 | 8.98 157 | 131   | 8.98 358 | 133   | 1.01 642 | 9.99 800 |       |
| 31 | 8.98 288 | 131   | 8.98 490 | 132   | 1.01 510 | 9.99 798 |       |
| 32 | 8.98 419 | 131   | 8.98 622 | 132   | 1.01 378 | 9.99 797 |       |
| 33 | 8.98 549 | 130   | 8.98 753 | 131   | 1.01 247 | 9.99 796 |       |
| 34 | 8.98 679 | 130   | 8.98 884 | 131   | 1.01 116 | 9.99 795 |       |
| 35 | 8.98 808 | 129   | 8.99 015 | 131   | 1.00 985 | 9.99 793 |       |
| 36 | 8.98 937 | 129   | 8.99 145 | 130   | 1.00 855 | 9.99 792 |       |
| 37 | 8.99 066 | 128   | 8.99 275 | 130   | 1.00 725 | 9.99 791 |       |
| 38 | 8.99 194 | 128   | 8.99 405 | 129   | 1.00 595 | 9.99 790 |       |
| 39 | 8.99 322 | 128   | 8.99 534 | 128   | 1.00 466 | 9.99 788 |       |
| 40 | 8.99 450 | 127   | 8.99 662 | 128   | 1.00 338 | 9.99 787 |       |
| 41 | 8.99 577 | 127   | 8.99 791 | 129   | 1.00 209 | 9.99 786 |       |
| 42 | 8.99 704 | 126   | 8.99 919 | 128   | 1.00 081 | 9.99 785 |       |
| 43 | 8.99 830 | 126   | 9.00 046 | 127   | 0.99 954 | 9.99 783 |       |
| 44 | 8.99 956 | 126   | 9.00 174 | 126   | 0.99 826 | 9.99 782 |       |
| 45 | 9.00 082 | 125   | 9.00 301 | 127   | 0.99 699 | 9.99 781 |       |
| 46 | 9.00 207 | 125   | 9.00 427 | 126   | 0.99 573 | 9.99 780 |       |
| 47 | 9.00 332 | 125   | 9.00 553 | 126   | 0.99 447 | 9.99 778 |       |
| 48 | 9.00 456 | 124   | 9.00 679 | 126   | 0.99 321 | 9.99 777 |       |
| 49 | 9.00 581 | 125   | 9.00 805 | 126   | 0.99 195 | 9.99 776 |       |
| 50 | 9.00 704 | 123   | 9.00 930 | 125   | 0.99 070 | 9.99 775 |       |
| 51 | 9.00 828 | 124   | 9.01 055 | 125   | 0.98 945 | 9.99 773 |       |
| 52 | 9.00 951 | 123   | 9.01 179 | 124   | 0.98 821 | 9.99 772 |       |
| 53 | 9.01 074 | 123   | 9.01 303 | 124   | 0.98 697 | 9.99 771 |       |
| 54 | 9.01 196 | 122   | 9.01 427 | 124   | 0.98 573 | 9.99 769 |       |
| 55 | 9.01 318 | 122   | 9.01 550 | 123   | 0.98 450 | 9.99 768 |       |
| 56 | 9.01 440 | 122   | 9.01 673 | 123   | 0.98 327 | 9.99 767 |       |
| 57 | 9.01 561 | 121   | 9.01 796 | 123   | 0.98 204 | 9.99 765 |       |
| 58 | 9.01 682 | 121   | 9.01 918 | 122   | 0.98 082 | 9.99 764 |       |
| 59 | 9.01 803 | 121   | 9.02 040 | 122   | 0.97 960 | 9.99 763 |       |
| 60 | 9.01 923 | 120   | 9.02 162 | 122   | 0.97 838 | 9.99 761 |       |
|    | L. Cos.  | d.    | L. Cot.  | c.d.  | L. Tan.  | L. Sin.  | P. P. |
| 1  | 14.7     | 14.6  | 14.5     | 14.4  |          |          |       |
| 2  | 29.4     | 29.2  | 29.0     | 28.8  |          |          |       |
| 3  | 44.1     | 43.8  | 43.5     | 43.2  |          |          |       |
| 4  | 58.8     | 58.4  | 58.0     | 57.6  |          |          |       |
| 5  | 73.5     | 73.0  | 72.5     | 72.0  |          |          |       |
| 6  | 88.2     | 87.6  | 87.0     | 86.4  |          |          |       |
| 7  | 102.9    | 102.2 | 101.5    | 100.8 |          |          |       |
| 8  | 117.6    | 116.8 | 116.0    | 115.2 |          |          |       |
| 9  | 132.3    | 131.4 | 130.5    | 129.6 |          |          |       |
| 10 | 143      | 142   | 141      | 140   |          |          |       |
| 11 | 14.3     | 14.2  | 14.1     | 14.0  |          |          |       |
| 12 | 28.6     | 28.4  | 28.2     | 28.0  |          |          |       |
| 13 | 42.9     | 42.6  | 42.3     | 42.0  |          |          |       |
| 14 | 57.2     | 56.8  | 56.4     | 56.0  |          |          |       |
| 15 | 71.5     | 71.0  | 70.5     | 70.0  |          |          |       |
| 16 | 85.8     | 85.2  | 84.6     | 84.0  |          |          |       |
| 17 | 100.1    | 99.4  | 98.7     | 98.0  |          |          |       |
| 18 | 114.4    | 113.6 | 112.8    | 112.0 |          |          |       |
| 19 | 128.7    | 127.8 | 126.9    | 126.0 |          |          |       |
| 20 | 139      | 138   | 137      | 136   |          |          |       |
| 21 | 13.9     | 13.8  | 13.7     | 13.6  |          |          |       |
| 22 | 27.8     | 27.6  | 27.4     | 27.2  |          |          |       |
| 23 | 41.7     | 41.4  | 41.2     | 40.8  |          |          |       |
| 24 | 55.6     | 55.2  | 54.8     | 54.4  |          |          |       |
| 25 | 69.5     | 69.0  | 68.5     | 68.0  |          |          |       |
| 26 | 83.4     | 82.8  | 82.2     | 81.6  |          |          |       |
| 27 | 97.3     | 96.5  | 95.9     | 95.2  |          |          |       |
| 28 | 111.2    | 110.4 | 109.6    | 108.8 |          |          |       |
| 29 | 125.1    | 124.2 | 123.3    | 122.4 |          |          |       |
| 30 | 135      | 134   | 133      | 132   |          |          |       |
| 31 | 13.5     | 13.4  | 13.3     | 13.2  |          |          |       |
| 32 | 27.0     | 26.8  | 26.5     | 26.4  |          |          |       |
| 33 | 40.5     | 40.2  | 39.9     | 39.7  |          |          |       |
| 34 | 54.0     | 53.4  | 52.8     | 52.4  |          |          |       |
| 35 | 67.5     | 67.0  | 66.5     | 66.0  |          |          |       |
| 36 | 81.0     | 80.4  | 79.8     | 79.2  |          |          |       |
| 37 | 94.5     | 93.8  | 93.2     | 92.4  |          |          |       |
| 38 | 108.0    | 107.2 | 106.4    | 105.6 |          |          |       |
| 39 | 121.5    | 120.6 | 119.7    | 118.8 |          |          |       |
| 40 | 131      | 130   | 129      | 128   |          |          |       |
| 41 | 13.1     | 13.0  | 12.9     | 12.8  |          |          |       |
| 42 | 26.2     | 26.0  | 25.8     | 25.6  |          |          |       |
| 43 | 39.3     | 39.0  | 38.7     | 38.4  |          |          |       |
| 44 | 52.4     | 52.0  | 51.6     | 51.2  |          |          |       |
| 45 | 65.5     | 65.0  | 64.5     | 64.0  |          |          |       |
| 46 | 78.6     | 78.0  | 77.4     | 76.8  |          |          |       |
| 47 | 91.7     | 91.0  | 90.3     | 89.6  |          |          |       |
| 48 | 104.8    | 104.0 | 103.2    | 102.4 |          |          |       |
| 49 | 117.9    | 117.0 | 116.1    | 115.2 |          |          |       |
| 50 | 127      | 126   | 125      | 124   |          |          |       |
| 51 | 12.7     | 12.6  | 12.5     | 12.4  |          |          |       |
| 52 | 25.4     | 25.2  | 25.0     | 24.8  |          |          |       |
| 53 | 38.1     | 37.8  | 37.5     | 37.2  |          |          |       |
| 54 | 50.8     | 50.4  | 50.0     | 49.6  |          |          |       |
| 55 | 63.5     | 63.0  | 62.5     | 62.0  |          |          |       |
| 56 | 76.2     | 75.6  | 75.0     | 74.4  |          |          |       |
| 57 | 88.9     | 88.2  | 87.5     | 86.8  |          |          |       |
| 58 | 101.6    | 100.8 | 100.0    | 99.2  |          |          |       |
| 59 | 114.3    | 113.4 | 112.5    | 111.6 |          |          |       |
| 60 | 123      | 122   | 121      | 120   |          |          |       |
| 1  | 12.3     | 12.2  | 12.1     | 12.0  |          |          |       |
| 2  | 24.6     | 24.4  | 24.2     | 24.0  |          |          |       |
| 3  | 36.9     | 36.6  | 36.3     | 36.0  |          |          |       |
| 4  | 49.2     | 48.8  | 48.4     | 48.0  |          |          |       |
| 5  | 61.5     | 61.0  | 60.5     | 60.0  |          |          |       |
| 6  | 73.8     | 73.2  | 72.6     | 72.0  |          |          |       |
| 7  | 86.1     | 85.4  | 84.7     | 84.0  |          |          |       |
| 8  | 98.4     | 97.6  | 96.8     | 96.0  |          |          |       |
| 9  | 110.7    | 109.8 | 108.9    | 108.0 |          |          |       |
| 0  |          |       |          |       |          |          |       |

|    | L. Sin.  | d.  | L. Tan.  | c.d.  | L. Cot.  | L. Cos.  |    | P. P. |
|----|----------|-----|----------|-------|----------|----------|----|-------|
| 1  | 9.01 923 | 120 | 9.02 162 | 121   | 0.97 838 | 9.99 761 | 60 |       |
| 0  | 9.02 043 | 120 | 9.02 283 | 121   | 0.97 717 | 9.99 760 | 59 |       |
| 2  | 9.02 163 | 120 | 9.02 404 | 121   | 0.97 596 | 9.99 759 | 58 |       |
| 3  | 9.02 283 | 119 | 9.02 525 | 120   | 0.97 475 | 9.99 757 | 57 |       |
| 4  | 9.02 402 | 118 | 9.02 645 | 121   | 0.97 355 | 9.99 756 | 56 |       |
| 5  | 9.02 520 | 119 | 9.02 766 | 119   | 0.97 234 | 9.99 755 | 55 |       |
| 6  | 9.02 639 | 118 | 9.02 885 | 120   | 0.97 115 | 9.99 753 | 54 |       |
| 7  | 9.02 757 | 117 | 9.03 005 | 119   | 0.96 995 | 9.99 752 | 53 |       |
| 8  | 9.02 874 | 118 | 9.03 124 | 118   | 0.96 876 | 9.99 751 | 52 |       |
| 9  | 9.02 992 | 117 | 9.03 242 | 119   | 0.96 758 | 9.99 749 | 51 |       |
| 10 | 9.03 109 | 117 | 9.03 361 | 118   | 0.96 639 | 9.99 748 | 50 |       |
| 11 | 9.03 226 | 116 | 9.03 479 | 118   | 0.96 521 | 9.99 747 | 49 |       |
| 12 | 9.03 342 | 116 | 9.03 597 | 117   | 0.96 403 | 9.99 745 | 48 |       |
| 13 | 9.03 458 | 116 | 9.03 714 | 118   | 0.96 286 | 9.99 744 | 47 |       |
| 14 | 9.03 574 | 116 | 9.03 832 | 116   | 0.96 168 | 9.99 742 | 46 |       |
| 15 | 9.03 690 | 115 | 9.03 948 | 117   | 0.96 052 | 9.99 741 | 45 |       |
| 16 | 9.03 805 | 115 | 9.04 065 | 116   | 0.95 935 | 9.99 740 | 44 |       |
| 17 | 9.03 920 | 115 | 9.04 181 | 116   | 0.95 819 | 9.99 738 | 43 |       |
| 18 | 9.04 034 | 114 | 9.04 297 | 116   | 0.95 703 | 9.99 737 | 42 |       |
| 19 | 9.04 149 | 113 | 9.04 413 | 115   | 0.95 587 | 9.99 736 | 41 |       |
| 20 | 9.04 262 | 114 | 9.04 528 | 115   | 0.95 472 | 9.99 734 | 40 |       |
| 21 | 9.04 376 | 114 | 9.04 643 | 115   | 0.95 357 | 9.99 733 | 39 |       |
| 22 | 9.04 490 | 113 | 9.04 758 | 115   | 0.95 242 | 9.99 731 | 38 |       |
| 23 | 9.04 603 | 112 | 9.04 873 | 114   | 0.95 127 | 9.99 730 | 37 |       |
| 24 | 9.04 715 | 113 | 9.04 987 | 114   | 0.95 013 | 9.99 728 | 36 |       |
| 25 | 9.04 828 | 112 | 9.05 101 | 113   | 0.94 899 | 9.99 727 | 35 |       |
| 26 | 9.04 940 | 112 | 9.05 214 | 114   | 0.94 786 | 9.99 726 | 34 |       |
| 27 | 9.05 052 | 112 | 9.05 328 | 113   | 0.94 672 | 9.99 724 | 33 |       |
| 28 | 9.05 164 | 111 | 9.05 441 | 112   | 0.94 559 | 9.99 723 | 32 |       |
| 29 | 9.05 275 | 111 | 9.05 553 | 113   | 0.94 447 | 9.99 721 | 31 |       |
| 30 | 9.05 386 | 111 | 9.05 666 | 112   | 0.94 334 | 9.99 720 | 30 |       |
| 31 | 9.05 497 | 110 | 9.05 778 | 112   | 0.94 222 | 9.99 718 | 29 |       |
| 32 | 9.05 607 | 110 | 9.05 890 | 112   | 0.94 110 | 9.99 717 | 28 |       |
| 33 | 9.05 717 | 110 | 9.06 002 | 111   | 0.93 998 | 9.99 716 | 27 |       |
| 34 | 9.05 827 | 110 | 9.06 113 | 111   | 0.93 887 | 9.99 714 | 26 |       |
| 35 | 9.05 937 | 109 | 9.06 224 | 111   | 0.93 776 | 9.99 713 | 25 |       |
| 36 | 9.06 046 | 109 | 9.06 335 | 110   | 0.93 665 | 9.99 711 | 24 |       |
| 37 | 9.06 155 | 109 | 9.06 445 | 110   | 0.93 555 | 9.99 710 | 23 |       |
| 38 | 9.06 264 | 108 | 9.06 556 | 110   | 0.93 444 | 9.99 708 | 22 |       |
| 39 | 9.06 372 | 109 | 9.06 666 | 109   | 0.93 334 | 9.99 707 | 21 |       |
| 40 | 9.06 481 | 108 | 9.06 775 | 110   | 0.93 225 | 9.99 705 | 20 |       |
| 41 | 9.06 589 | 107 | 9.06 885 | 109   | 0.93 115 | 9.99 704 | 19 |       |
| 42 | 9.06 696 | 108 | 9.06 994 | 109   | 0.93 006 | 9.99 702 | 18 |       |
| 43 | 9.06 804 | 107 | 9.07 103 | 108   | 0.92 897 | 9.99 701 | 17 |       |
| 44 | 9.06 911 | 107 | 9.07 211 | 109   | 0.92 789 | 9.99 699 | 16 |       |
| 45 | 9.07 018 | 106 | 9.07 320 | 108   | 0.92 680 | 9.99 698 | 15 |       |
| 46 | 9.07 124 | 106 | 9.07 428 | 108   | 0.92 572 | 9.99 696 | 14 |       |
| 47 | 9.07 231 | 107 | 9.07 536 | 107   | 0.92 464 | 9.99 695 | 13 |       |
| 48 | 9.07 337 | 106 | 9.07 643 | 108   | 0.92 357 | 9.99 693 | 12 |       |
| 49 | 9.07 442 | 106 | 9.07 751 | 107   | 0.92 249 | 9.99 692 | 11 |       |
| 50 | 9.07 548 | 105 | 9.07 858 | 106   | 0.92 142 | 9.99 690 | 10 |       |
| 51 | 9.07 653 | 105 | 9.07 964 | 107   | 0.92 036 | 9.99 689 | 9  |       |
| 52 | 9.07 758 | 105 | 9.08 071 | 106   | 0.91 929 | 9.99 687 | 8  |       |
| 53 | 9.07 863 | 105 | 9.08 177 | 106   | 0.91 823 | 9.99 686 | 7  |       |
| 54 | 9.07 968 | 104 | 9.08 283 | 106   | 0.91 717 | 9.99 684 | 6  |       |
| 55 | 9.08 072 | 104 | 9.08 389 | 106   | 0.91 611 | 9.99 683 | 5  |       |
| 56 | 9.08 176 | 104 | 9.08 495 | 105   | 0.91 505 | 9.99 681 | 4  |       |
| 57 | 9.08 280 | 103 | 9.08 600 | 105   | 0.91 400 | 9.99 680 | 3  |       |
| 58 | 9.08 383 | 103 | 9.08 705 | 105   | 0.91 295 | 9.99 678 | 2  |       |
| 59 | 9.08 486 | 103 | 9.08 810 | 104   | 0.91 190 | 9.99 677 | 1  |       |
| 60 | 9.08 589 | 103 | 9.08 914 | 104   | 0.91 086 | 9.99 675 | 0  |       |
|    | L. Cos.  | d.  | L. Cot.  | c. d. | L. Tan.  | L. Sin.  |    | P. P. |

| r  | L. Sin.  |     |          |       | c. d.   | L. Cot.  |          | L. Cos. | 60 | P. P. |  |  |
|----|----------|-----|----------|-------|---------|----------|----------|---------|----|-------|--|--|
|    | L. Sin.  | d.  | L. Tan.  | c. d. |         | L. Cot.  | L. Cos.  |         |    | P. P. |  |  |
| 0  | 9.08 589 |     | 9.08 914 |       | 105     | 0.91 086 | 9.99 675 | 60      |    |       |  |  |
| 1  | 9.08 692 | 103 | 9.09 019 | 104   | 105     | 0.90 981 | 9.99 674 | 59      |    |       |  |  |
| 2  | 9.08 795 | 102 | 9.09 123 | 104   | 104     | 0.90 877 | 9.99 672 | 58      |    |       |  |  |
| 3  | 9.08 897 | 102 | 9.09 227 | 104   | 104     | 0.90 773 | 9.99 670 | 57      |    |       |  |  |
| 4  | 9.08 999 | 102 | 9.09 330 | 103   | 103     | 0.90 670 | 9.99 669 | 56      |    |       |  |  |
| 5  | 9.09 101 | 102 | 9.09 434 | 104   | 104     | 0.90 566 | 9.99 667 | 55      |    |       |  |  |
| 6  | 9.09 202 | 102 | 9.09 537 | 103   | 103     | 0.90 463 | 9.99 666 | 54      |    |       |  |  |
| 7  | 9.09 304 | 101 | 9.09 640 | 102   | 102     | 0.90 360 | 9.99 664 | 53      |    |       |  |  |
| 8  | 9.09 405 | 101 | 9.09 742 | 102   | 102     | 0.90 258 | 9.99 663 | 52      |    |       |  |  |
| 9  | 9.09 506 | 100 | 9.09 843 | 103   | 103     | 0.90 155 | 9.99 661 | 51      |    |       |  |  |
| 10 | 9.09 606 | 101 | 9.09 947 | 102   | 102     | 0.90 053 | 9.99 659 | 50      |    |       |  |  |
| 11 | 9.09 707 | 100 | 9.10 049 | 101   | 101     | 0.89 951 | 9.99 658 | 49      |    |       |  |  |
| 12 | 9.09 807 | 100 | 9.10 150 | 102   | 102     | 0.89 850 | 9.99 656 | 48      |    |       |  |  |
| 13 | 9.09 907 | 99  | 9.10 252 | 101   | 101     | 0.89 748 | 9.99 655 | 47      |    |       |  |  |
| 14 | 9.10 006 | 99  | 9.10 353 | 101   | 101     | 0.89 647 | 9.99 653 | 46      |    |       |  |  |
| 15 | 9.10 105 | 99  | 9.10 454 | 101   | 101     | 0.89 546 | 9.99 651 | 45      |    |       |  |  |
| 16 | 9.10 205 | 99  | 9.10 555 | 101   | 101     | 0.89 445 | 9.99 650 | 44      |    |       |  |  |
| 17 | 9.10 304 | 98  | 9.10 656 | 100   | 100     | 0.89 344 | 9.99 648 | 43      |    |       |  |  |
| 18 | 9.10 402 | 99  | 9.10 756 | 100   | 100     | 0.89 244 | 9.99 647 | 42      |    |       |  |  |
| 19 | 9.10 501 | 98  | 9.10 856 | 100   | 100     | 0.89 144 | 9.99 645 | 41      |    |       |  |  |
| 20 | 9.10 599 | 98  | 9.10 956 | 100   | 100     | 0.89 044 | 9.99 643 | 40      |    |       |  |  |
| 21 | 9.10 697 | 98  | 9.11 056 | 99    | 99      | 0.88 944 | 9.99 642 | 39      |    |       |  |  |
| 22 | 9.10 795 | 98  | 9.11 155 | 99    | 99      | 0.88 845 | 9.99 640 | 38      |    |       |  |  |
| 23 | 9.10 893 | 97  | 9.11 254 | 99    | 99      | 0.88 746 | 9.99 638 | 37      |    |       |  |  |
| 24 | 9.10 990 | 97  | 9.11 353 | 99    | 99      | 0.88 647 | 9.99 637 | 36      |    |       |  |  |
| 25 | 9.11 087 | 97  | 9.11 452 | 99    | 99      | 0.88 548 | 9.99 635 | 35      |    |       |  |  |
| 26 | 9.11 184 | 97  | 9.11 551 | 98    | 98      | 0.88 449 | 9.99 633 | 34      |    |       |  |  |
| 27 | 9.11 281 | 97  | 9.11 649 | 98    | 98      | 0.88 351 | 9.99 632 | 33      |    |       |  |  |
| 28 | 9.11 377 | 96  | 9.11 747 | 98    | 98      | 0.88 253 | 9.99 630 | 32      |    |       |  |  |
| 29 | 9.11 474 | 96  | 9.11 845 | 98    | 98      | 0.88 155 | 9.99 629 | 31      |    |       |  |  |
| 30 | 9.11 570 | 96  | 9.11 943 | 97    | 97      | 0.88 057 | 9.99 627 | 30      |    |       |  |  |
| 31 | 9.11 666 | 95  | 9.12 040 | 98    | 98      | 0.87 960 | 9.99 625 | 29      |    |       |  |  |
| 32 | 9.11 761 | 95  | 9.12 138 | 97    | 97      | 0.87 862 | 9.99 624 | 28      |    |       |  |  |
| 33 | 9.11 857 | 95  | 9.12 235 | 97    | 97      | 0.87 765 | 9.99 622 | 27      |    |       |  |  |
| 34 | 9.11 952 | 95  | 9.12 332 | 97    | 97      | 0.87 668 | 9.99 620 | 26      |    |       |  |  |
| 35 | 9.12 047 | 95  | 9.12 428 | 96    | 96      | 0.87 572 | 9.99 618 | 25      |    |       |  |  |
| 36 | 9.12 142 | 95  | 9.12 525 | 97    | 97      | 0.87 475 | 9.99 617 | 24      |    |       |  |  |
| 37 | 9.12 236 | 94  | 9.12 621 | 96    | 96      | 0.87 379 | 9.99 615 | 23      |    |       |  |  |
| 38 | 9.12 331 | 95  | 9.12 717 | 96    | 96      | 0.87 283 | 9.99 613 | 22      |    |       |  |  |
| 39 | 9.12 425 | 94  | 9.12 813 | 96    | 96      | 0.87 187 | 9.99 612 | 21      |    |       |  |  |
| 40 | 9.12 519 | 94  | 9.12 909 | 95    | 95      | 0.87 091 | 9.99 610 | 20      |    |       |  |  |
| 41 | 9.12 612 | 93  | 9.13 004 | 95    | 95      | 0.86 996 | 9.99 608 | 19      |    |       |  |  |
| 42 | 9.12 706 | 93  | 9.13 099 | 95    | 95      | 0.86 901 | 9.99 607 | 18      |    |       |  |  |
| 43 | 9.12 799 | 93  | 9.13 194 | 95    | 95      | 0.86 806 | 9.99 605 | 17      |    |       |  |  |
| 44 | 9.12 892 | 93  | 9.13 289 | 95    | 95      | 0.86 711 | 9.99 603 | 16      |    |       |  |  |
| 45 | 9.12 985 | 93  | 9.13 384 | 95    | 95      | 0.86 616 | 9.99 601 | 15      |    |       |  |  |
| 46 | 9.13 078 | 93  | 9.13 478 | 94    | 94      | 0.86 522 | 9.99 600 | 14      |    |       |  |  |
| 47 | 9.13 171 | 92  | 9.13 573 | 94    | 94      | 0.86 427 | 9.99 598 | 13      |    |       |  |  |
| 48 | 9.13 263 | 92  | 9.13 667 | 94    | 94      | 0.86 333 | 9.99 596 | 12      |    |       |  |  |
| 49 | 9.13 355 | 92  | 9.13 761 | 94    | 94      | 0.86 239 | 9.99 595 | 11      |    |       |  |  |
| 50 | 9.13 447 | 92  | 9.13 854 | 93    | 93      | 0.86 146 | 9.99 593 | 10      |    |       |  |  |
| 51 | 9.13 539 | 91  | 9.13 948 | 94    | 94      | 0.86 052 | 9.99 591 | 9       |    |       |  |  |
| 52 | 9.13 630 | 92  | 9.14 041 | 93    | 93      | 0.85 959 | 9.99 589 | 8       |    |       |  |  |
| 53 | 9.13 722 | 91  | 9.14 134 | 93    | 93      | 0.85 866 | 9.99 588 | 7       |    |       |  |  |
| 54 | 9.13 813 | 91  | 9.14 227 | 93    | 93      | 0.85 773 | 9.99 586 | 6       |    |       |  |  |
| 55 | 9.13 904 | 90  | 9.14 320 | 92    | 92      | 0.85 680 | 9.99 584 | 5       |    |       |  |  |
| 56 | 9.13 994 | 91  | 9.14 412 | 92    | 92      | 0.85 588 | 9.99 582 | 4       |    |       |  |  |
| 57 | 9.14 085 | 90  | 9.14 504 | 91    | 91      | 0.85 496 | 9.99 581 | 3       |    |       |  |  |
| 58 | 9.14 175 | 91  | 9.14 597 | 91    | 91      | 0.85 403 | 9.99 579 | 2       |    |       |  |  |
| 59 | 9.14 266 | 90  | 9.14 688 | 92    | 92      | 0.85 312 | 9.99 577 | 1       |    |       |  |  |
| 60 | 9.14 356 |     | 9.14 780 |       |         | 0.85 220 | 9.99 575 | 0       |    |       |  |  |
|    | L. Cos.  | d.  | L. Tan.  | c. d. | L. Tan. | L. Sin.  |          |         |    | P. P. |  |  |



|    | L. Sin.  | d. | L. Tan.  | c.d.  | L. Cot.  | L. Cos.  |    | P. P. |  |  |
|----|----------|----|----------|-------|----------|----------|----|-------|--|--|
| 0  | 9.14 356 | 89 | 9.14 780 | 92    | 0.85 220 | 9.99 575 | 60 |       |  |  |
| 1  | 9.14 445 | 90 | 9.14 872 | 91    | 0.85 128 | 9.99 574 | 59 |       |  |  |
| 2  | 9.14 535 | 89 | 9.14 963 | 91    | 0.85 037 | 9.99 572 | 58 |       |  |  |
| 3  | 9.14 624 | 90 | 9.15 054 | 91    | 0.84 946 | 9.99 570 | 57 |       |  |  |
| 4  | 9.14 714 | 89 | 9.15 145 | 91    | 0.84 855 | 9.99 568 | 56 |       |  |  |
| 5  | 9.14 803 | 88 | 9.15 236 | 91    | 0.84 764 | 9.99 566 | 55 |       |  |  |
| 6  | 9.14 891 | 89 | 9.15 327 | 91    | 0.84 673 | 9.99 565 | 54 |       |  |  |
| 7  | 9.14 980 | 89 | 9.15 417 | 91    | 0.84 583 | 9.99 563 | 53 |       |  |  |
| 8  | 9.15 069 | 88 | 9.15 508 | 90    | 0.84 492 | 9.99 561 | 52 |       |  |  |
| 9  | 9.15 157 | 88 | 9.15 598 | 90    | 0.84 402 | 9.99 559 | 51 |       |  |  |
| 10 | 9.15 245 | 88 | 9.15 688 | 89    | 0.84 312 | 9.99 557 | 50 |       |  |  |
| 11 | 9.15 333 | 88 | 9.15 777 | 90    | 0.84 223 | 9.99 556 | 49 |       |  |  |
| 12 | 9.15 421 | 87 | 9.15 867 | 89    | 0.84 133 | 9.99 554 | 48 |       |  |  |
| 13 | 9.15 508 | 88 | 9.15 956 | 90    | 0.84 044 | 9.99 552 | 47 |       |  |  |
| 14 | 9.15 596 | 87 | 9.16 046 | 89    | 0.83 954 | 9.99 550 | 46 |       |  |  |
| 15 | 9.15 683 | 87 | 9.16 135 | 89    | 0.83 865 | 9.99 548 | 45 |       |  |  |
| 16 | 9.15 770 | 87 | 9.16 224 | 88    | 0.83 776 | 9.99 546 | 44 |       |  |  |
| 17 | 9.15 857 | 87 | 9.16 312 | 89    | 0.83 688 | 9.99 545 | 43 |       |  |  |
| 18 | 9.15 944 | 86 | 9.16 401 | 88    | 0.83 599 | 9.99 543 | 42 |       |  |  |
| 19 | 9.16 030 | 86 | 9.16 489 | 88    | 0.83 511 | 9.99 541 | 41 |       |  |  |
| 20 | 9.16 116 | 87 | 9.16 577 | 88    | 0.83 423 | 9.99 539 | 40 |       |  |  |
| 21 | 9.16 203 | 86 | 9.16 665 | 88    | 0.83 335 | 9.99 537 | 39 |       |  |  |
| 22 | 9.16 289 | 85 | 9.16 753 | 88    | 0.83 247 | 9.99 535 | 38 |       |  |  |
| 23 | 9.16 374 | 86 | 9.16 841 | 87    | 0.83 159 | 9.99 533 | 37 |       |  |  |
| 24 | 9.16 460 | 85 | 9.16 928 | 88    | 0.83 072 | 9.99 532 | 36 |       |  |  |
| 25 | 9.16 545 | 86 | 9.17 016 | 87    | 0.82 984 | 9.99 530 | 35 |       |  |  |
| 26 | 9.16 631 | 85 | 9.17 103 | 87    | 0.82 897 | 9.99 528 | 34 |       |  |  |
| 27 | 9.16 716 | 85 | 9.17 190 | 87    | 0.82 810 | 9.99 526 | 33 |       |  |  |
| 28 | 9.16 801 | 85 | 9.17 277 | 86    | 0.82 723 | 9.99 524 | 32 |       |  |  |
| 29 | 9.16 886 | 84 | 9.17 363 | 87    | 0.82 637 | 9.99 522 | 31 |       |  |  |
| 30 | 9.16 970 | 85 | 9.17 450 | 86    | 0.82 550 | 9.99 520 | 30 |       |  |  |
| 31 | 9.17 055 | 84 | 9.17 536 | 86    | 0.82 464 | 9.99 518 | 29 |       |  |  |
| 32 | 9.17 139 | 84 | 9.17 622 | 86    | 0.82 378 | 9.99 517 | 28 |       |  |  |
| 33 | 9.17 223 | 84 | 9.17 708 | 86    | 0.82 292 | 9.99 515 | 27 |       |  |  |
| 34 | 9.17 307 | 84 | 9.17 794 | 86    | 0.82 206 | 9.99 513 | 26 |       |  |  |
| 35 | 9.17 391 | 83 | 9.17 880 | 85    | 0.82 120 | 9.99 511 | 25 |       |  |  |
| 36 | 9.17 474 | 84 | 9.17 965 | 85    | 0.82 035 | 9.99 509 | 24 |       |  |  |
| 37 | 9.17 558 | 83 | 9.18 051 | 85    | 0.81 949 | 9.99 507 | 23 |       |  |  |
| 38 | 9.17 641 | 83 | 9.18 136 | 85    | 0.81 864 | 9.99 505 | 22 |       |  |  |
| 39 | 9.17 724 | 83 | 9.18 221 | 85    | 0.81 779 | 9.99 503 | 21 |       |  |  |
| 40 | 9.17 807 | 83 | 9.18 306 | 85    | 0.81 694 | 9.99 501 | 20 |       |  |  |
| 41 | 9.17 890 | 83 | 9.18 391 | 84    | 0.81 609 | 9.99 499 | 19 |       |  |  |
| 42 | 9.17 973 | 82 | 9.18 475 | 85    | 0.81 525 | 9.99 497 | 18 |       |  |  |
| 43 | 9.18 055 | 82 | 9.18 560 | 84    | 0.81 440 | 9.99 495 | 17 |       |  |  |
| 44 | 9.18 137 | 83 | 9.18 644 | 84    | 0.81 356 | 9.99 494 | 16 |       |  |  |
| 45 | 9.18 220 | 82 | 9.18 728 | 84    | 0.81 272 | 9.99 492 | 15 |       |  |  |
| 46 | 9.18 302 | 81 | 9.18 812 | 84    | 0.81 188 | 9.99 490 | 14 |       |  |  |
| 47 | 9.18 383 | 82 | 9.18 896 | 83    | 0.81 104 | 9.99 488 | 13 |       |  |  |
| 48 | 9.18 465 | 82 | 9.18 979 | 84    | 0.81 021 | 9.99 486 | 12 |       |  |  |
| 49 | 9.18 547 | 81 | 9.19 063 | 83    | 0.80 937 | 9.99 484 | 11 |       |  |  |
| 50 | 9.18 628 | 81 | 9.19 146 | 83    | 0.80 854 | 9.99 482 | 10 |       |  |  |
| 51 | 9.18 709 | 81 | 9.19 229 | 83    | 0.80 771 | 9.99 480 | 9  |       |  |  |
| 52 | 9.18 790 | 81 | 9.19 312 | 83    | 0.80 688 | 9.99 478 | 8  |       |  |  |
| 53 | 9.18 871 | 81 | 9.19 395 | 83    | 0.80 605 | 9.99 476 | 7  |       |  |  |
| 54 | 9.18 952 | 81 | 9.19 478 | 83    | 0.80 522 | 9.99 474 | 6  |       |  |  |
| 55 | 9.19 033 | 80 | 9.19 561 | 83    | 0.80 439 | 9.99 472 | 5  |       |  |  |
| 56 | 9.19 113 | 80 | 9.19 643 | 82    | 0.80 357 | 9.99 470 | 4  |       |  |  |
| 57 | 9.19 193 | 80 | 9.19 725 | 82    | 0.80 275 | 9.99 468 | 3  |       |  |  |
| 58 | 9.19 273 | 80 | 9.19 807 | 82    | 0.80 193 | 9.99 466 | 2  |       |  |  |
| 59 | 9.19 353 | 80 | 9.19 889 | 82    | 0.80 111 | 9.99 464 | 1  |       |  |  |
| 60 | 9.19 433 |    | 9.19 971 |       | 0.80 029 | 9.99 462 | 0  |       |  |  |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  |    | P. P. |  |  |

|    | L. Sin.  | d. | L. Tan.  | c.d. | L. Cot.  | L. Cos.  |    | P. P.            |
|----|----------|----|----------|------|----------|----------|----|------------------|
| 0  | 9.19 433 | 80 | 9.19 971 | 82   | 0.80 029 | 9.99 462 | 60 |                  |
| 1  | 9.19 513 | 79 | 9.20 053 | 81   | 0.79 947 | 9.99 460 | 59 |                  |
| 2  | 9.19 592 | 78 | 9.20 134 | 82   | 0.79 866 | 9.99 458 | 58 |                  |
| 3  | 9.19 672 | 79 | 9.20 216 | 81   | 0.79 784 | 9.99 456 | 57 | 82 81 80         |
| 4  | 9.19 751 | 79 | 9.20 297 | 81   | 0.79 703 | 9.99 454 | 56 | 1 8.2 8.1 8.0    |
| 5  | 9.19 830 | 79 | 9.20 378 | 81   | 0.79 622 | 9.99 452 | 55 | 2 16.4 16.2 16.0 |
| 6  | 9.19 909 | 79 | 9.20 459 | 81   | 0.79 541 | 9.99 450 | 54 | 3 24.6 24.3 24.0 |
| 7  | 9.19 988 | 79 | 9.20 540 | 81   | 0.79 460 | 9.99 448 | 53 | 4 32.8 32.4 32.0 |
| 8  | 9.20 067 | 78 | 9.20 621 | 80   | 0.79 379 | 9.99 446 | 52 | 5 41.0 40.5 40.0 |
| 9  | 9.20 145 | 78 | 9.20 701 | 81   | 0.79 299 | 9.99 444 | 51 | 6 49.2 48.6 48.0 |
| 10 | 9.20 223 | 78 | 9.20 782 | 80   | 0.79 218 | 9.99 442 | 50 | 7 57.4 56.7 56.0 |
| 11 | 9.20 302 | 78 | 9.20 862 | 80   | 0.79 138 | 9.99 440 | 49 | 8 65.6 64.8 64.0 |
| 12 | 9.20 380 | 78 | 9.20 942 | 80   | 0.79 058 | 9.99 438 | 48 | 9 73.8 72.9 72.0 |
| 13 | 9.20 458 | 78 | 9.21 022 | 80   | 0.78 978 | 9.99 436 | 47 |                  |
| 14 | 9.20 535 | 77 | 9.21 102 | 80   | 0.78 898 | 9.99 434 | 46 | 79 78 77         |
| 15 | 9.20 613 | 78 | 9.21 182 | 79   | 0.78 818 | 9.99 432 | 45 | 1 7.9 7.8 7.7    |
| 16 | 9.20 691 | 78 | 9.21 261 | 79   | 0.78 739 | 9.99 429 | 44 | 2 15.8 15.6 15.4 |
| 17 | 9.20 768 | 77 | 9.21 341 | 80   | 0.78 659 | 9.99 427 | 43 | 3 23.7 23.4 23.1 |
| 18 | 9.20 845 | 77 | 9.21 420 | 79   | 0.78 580 | 9.99 425 | 42 | 4 31.6 31.2 30.8 |
| 19 | 9.20 922 | 77 | 9.21 499 | 79   | 0.78 501 | 9.99 423 | 41 | 5 39.5 39.0 38.5 |
| 20 | 9.20 999 | 77 | 9.21 578 | 79   | 0.78 422 | 9.99 421 | 40 | 6 47.4 46.8 46.2 |
| 21 | 9.21 076 | 77 | 9.21 657 | 79   | 0.78 343 | 9.99 419 | 39 | 7 55.3 54.6 53.9 |
| 22 | 9.21 153 | 77 | 9.21 736 | 78   | 0.78 264 | 9.99 417 | 38 | 8 63.2 62.4 61.6 |
| 23 | 9.21 229 | 76 | 9.21 814 | 78   | 0.78 186 | 9.99 415 | 37 | 9 71.1 70.2 69.3 |
| 24 | 9.21 306 | 77 | 9.21 893 | 79   | 0.78 107 | 9.99 413 | 36 |                  |
| 25 | 9.21 382 | 76 | 9.21 971 | 78   | 0.78 029 | 9.99 411 | 35 | 76 75 74         |
| 26 | 9.21 458 | 76 | 9.22 049 | 78   | 0.77 951 | 9.99 409 | 34 | 1 7.6 7.5 7.4    |
| 27 | 9.21 534 | 76 | 9.22 127 | 78   | 0.77 873 | 9.99 407 | 33 | 2 15.2 15.0 14.8 |
| 28 | 9.21 610 | 76 | 9.22 205 | 78   | 0.77 795 | 9.99 404 | 32 | 3 22.8 22.5 22.2 |
| 29 | 9.21 685 | 75 | 9.22 283 | 78   | 0.77 717 | 9.99 402 | 31 | 4 30.4 30.0 29.6 |
| 30 | 9.21 761 | 76 | 9.22 361 | 77   | 0.77 639 | 9.99 400 | 30 | 5 38.0 37.5 37.0 |
| 31 | 9.21 836 | 75 | 9.22 438 | 77   | 0.77 562 | 9.99 398 | 29 | 6 45.6 45.0 44.4 |
| 32 | 9.21 912 | 76 | 9.22 516 | 78   | 0.77 484 | 9.99 396 | 28 | 7 53.2 52.5 51.8 |
| 33 | 9.21 987 | 75 | 9.22 593 | 77   | 0.77 407 | 9.99 394 | 27 | 8 60.8 60.0 59.2 |
| 34 | 9.22 062 | 75 | 9.22 670 | 77   | 0.77 330 | 9.99 392 | 26 | 9 68.4 67.5 66.6 |
| 35 | 9.22 137 | 75 | 9.22 747 | 77   | 0.77 253 | 9.99 390 | 25 |                  |
| 36 | 9.22 211 | 74 | 9.22 824 | 77   | 0.77 176 | 9.99 388 | 24 | 78 72 71         |
| 37 | 9.22 286 | 75 | 9.22 901 | 77   | 0.77 099 | 9.99 385 | 23 | 1 7.3 7.2 7.1    |
| 38 | 9.22 361 | 75 | 9.22 977 | 76   | 0.77 023 | 9.99 383 | 22 | 2 14.6 14.4 14.2 |
| 39 | 9.22 435 | 74 | 9.23 054 | 77   | 0.76 946 | 9.99 381 | 21 | 3 21.9 21.6 21.3 |
| 40 | 9.22 509 | 74 | 9.23 130 | 76   | 0.76 870 | 9.99 379 | 20 | 4 29.2 28.8 28.4 |
| 41 | 9.22 583 | 74 | 9.23 206 | 76   | 0.76 794 | 9.99 377 | 19 | 5 36.5 36.0 35.5 |
| 42 | 9.22 657 | 74 | 9.23 283 | 77   | 0.76 717 | 9.99 375 | 18 | 6 43.8 43.2 42.6 |
| 43 | 9.22 731 | 74 | 9.23 359 | 76   | 0.76 641 | 9.99 372 | 17 | 7 51.1 50.4 49.7 |
| 44 | 9.22 805 | 74 | 9.23 435 | 75   | 0.76 565 | 9.99 370 | 16 | 8 58.4 57.6 56.8 |
| 45 | 9.22 878 | 73 | 9.23 510 | 75   | 0.76 490 | 9.99 368 | 15 | 9 65.7 64.8 63.9 |
| 46 | 9.22 952 | 74 | 9.23 586 | 76   | 0.76 414 | 9.99 366 | 14 |                  |
| 47 | 9.23 025 | 73 | 9.23 661 | 75   | 0.76 339 | 9.99 364 | 13 |                  |
| 48 | 9.23 098 | 73 | 9.23 737 | 76   | 0.76 263 | 9.99 362 | 12 | 3 8 3            |
| 49 | 9.23 171 | 73 | 9.23 812 | 75   | 0.76 188 | 9.99 359 | 11 | 0 79 78 77       |
| 50 | 9.23 244 | 73 | 9.23 887 | 75   | 0.76 113 | 9.99 357 | 10 | 1 13.2 13.0 12.8 |
| 51 | 9.23 317 | 73 | 9.23 962 | 75   | 0.76 038 | 9.99 355 | 9  | 2 39.5 39.0 38.5 |
| 52 | 9.23 390 | 73 | 9.24 037 | 75   | 0.75 963 | 9.99 353 | 8  | 3 65.8 65.0 64.2 |
| 53 | 9.23 463 | 72 | 9.24 112 | 75   | 0.75 888 | 9.99 351 | 7  |                  |
| 54 | 9.23 535 | 73 | 9.24 186 | 74   | 0.75 814 | 9.99 348 | 6  | 8 3              |
| 55 | 9.23 607 | 72 | 9.24 261 | 75   | 0.75 739 | 9.99 346 | 5  | 0 76 75 74       |
| 56 | 9.23 679 | 72 | 9.24 335 | 74   | 0.75 665 | 9.99 344 | 4  | 1 12.7 12.5 12.3 |
| 57 | 9.23 752 | 73 | 9.24 410 | 75   | 0.75 590 | 9.99 342 | 3  | 2 38.0 37.5 37.0 |
| 58 | 9.23 823 | 71 | 9.24 484 | 74   | 0.75 516 | 9.99 340 | 2  | 3 63.3 62.5 61.7 |
| 59 | 9.23 895 | 72 | 9.24 558 | 74   | 0.75 442 | 9.99 337 | 1  |                  |
| 60 | 9.23 967 | 72 | 9.24 632 | 74   | 0.75 368 | 9.99 335 | 0  |                  |
|    | L. Cos.  | d. | L. Cot.  | c.d. | L. Tan.  | L. Sin.  |    | P. P.            |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.               |
|----|----------|----|----------|-------|----------|----------|----|----|---------------------|
| 0  | 9.23 967 | 72 | 9.24 632 | 74    | 0.75 368 | 9.99 335 | 2  | 60 |                     |
| 1  | 9.24 039 | 71 | 9.24 706 | 73    | 0.75 294 | 9.99 333 | 2  | 59 |                     |
| 2  | 9.24 110 | 71 | 9.24 779 | 73    | 0.75 221 | 9.99 331 | 2  | 58 |                     |
| 3  | 9.24 181 | 71 | 9.24 853 | 74    | 0.75 147 | 9.99 328 | 3  | 57 | 74 73 72            |
| 4  | 9.24 253 | 71 | 9.24 926 | 73    | 0.75 074 | 9.99 326 | 2  | 56 | 7.4 7.3 7.2         |
| 5  | 9.24 324 | 71 | 9.25 000 | 74    | 0.75 000 | 9.99 324 | 2  | 55 | 14.8 14.6 14.4      |
| 6  | 9.24 395 | 71 | 9.25 073 | 73    | 0.74 927 | 9.99 322 | 2  | 54 | 22.2 21.9 21.6      |
| 7  | 9.24 466 | 70 | 9.25 146 | 73    | 0.74 854 | 9.99 319 | 3  | 53 | 29.6 29.2 28.8      |
| 8  | 9.24 536 | 70 | 9.25 219 | 73    | 0.74 781 | 9.99 317 | 2  | 52 | 37.0 36.5 36.0      |
| 9  | 9.24 607 | 71 | 9.25 292 | 73    | 0.74 708 | 9.99 315 | 2  | 51 | 44.4 43.8 43.2      |
| 10 | 9.24 677 | 71 | 9.25 365 | 72    | 0.74 635 | 9.99 313 | 2  | 50 | 51.8 51.1 50.4      |
| 11 | 9.24 748 | 70 | 9.25 437 | 72    | 0.74 563 | 9.99 310 | 3  | 49 | 59.2 58.4 57.6      |
| 12 | 9.24 818 | 70 | 9.25 510 | 73    | 0.74 490 | 9.99 308 | 2  | 48 | 66.6 65.7 64.8      |
| 13 | 9.24 888 | 70 | 9.25 582 | 72    | 0.74 418 | 9.99 306 | 2  | 47 |                     |
| 14 | 9.24 958 | 70 | 9.25 655 | 73    | 0.74 345 | 9.99 304 | 3  | 46 | 71 70 69            |
| 15 | 9.25 028 | 70 | 9.25 727 | 72    | 0.74 273 | 9.99 301 | 2  | 45 | 7.1 7.0 6.9         |
| 16 | 9.25 098 | 70 | 9.25 799 | 72    | 0.74 201 | 9.99 299 | 2  | 44 | 14.2 14.0 13.8      |
| 17 | 9.25 168 | 69 | 9.25 871 | 72    | 0.74 129 | 9.99 297 | 2  | 43 | 21.3 21.0 20.7      |
| 18 | 9.25 237 | 70 | 9.25 943 | 72    | 0.74 057 | 9.99 294 | 3  | 42 | 28.4 28.0 27.6      |
| 19 | 9.25 307 | 69 | 9.26 015 | 71    | 0.73 985 | 9.99 292 | 2  | 41 | 35.5 35.0 34.5      |
| 20 | 9.25 376 | 69 | 9.26 086 | 72    | 0.73 914 | 9.99 290 | 2  | 40 | 42.6 42.0 41.4      |
| 21 | 9.25 445 | 69 | 9.26 158 | 71    | 0.73 842 | 9.99 288 | 3  | 39 | 49.7 49.0 48.3      |
| 22 | 9.25 514 | 69 | 9.26 229 | 72    | 0.73 771 | 9.99 285 | 2  | 38 | 56.8 56.0 55.2      |
| 23 | 9.25 583 | 69 | 9.26 301 | 71    | 0.73 699 | 9.99 283 | 3  | 37 | 63.9 63.0 62.1      |
| 24 | 9.25 652 | 69 | 9.26 372 | 71    | 0.73 628 | 9.99 281 | 2  | 36 |                     |
| 25 | 9.25 721 | 69 | 9.26 443 | 71    | 0.73 557 | 9.99 278 | 3  | 35 | 68 67 66            |
| 26 | 9.25 790 | 68 | 9.26 514 | 71    | 0.73 486 | 9.99 276 | 2  | 34 | 6.8 6.7 6.6         |
| 27 | 9.25 858 | 69 | 9.26 585 | 70    | 0.73 415 | 9.99 274 | 3  | 33 | 13.6 13.4 13.2      |
| 28 | 9.25 927 | 68 | 9.26 655 | 71    | 0.73 345 | 9.99 271 | 2  | 32 | 20.4 20.1 19.8      |
| 29 | 9.25 995 | 68 | 9.26 726 | 71    | 0.73 274 | 9.99 269 | 3  | 31 | 27.2 26.8 26.4      |
| 30 | 9.26 063 | 68 | 9.26 797 | 70    | 0.73 203 | 9.99 267 | 2  | 30 | 34.0 33.5 33.0      |
| 31 | 9.26 131 | 68 | 9.26 867 | 70    | 0.73 133 | 9.99 264 | 3  | 29 | 40.8 40.2 39.6      |
| 32 | 9.26 199 | 68 | 9.26 937 | 71    | 0.73 063 | 9.99 262 | 2  | 28 | 47.6 46.9 46.2      |
| 33 | 9.26 267 | 68 | 9.27 008 | 70    | 0.72 992 | 9.99 260 | 2  | 27 | 54.4 53.6 52.8      |
| 34 | 9.26 335 | 68 | 9.27 078 | 70    | 0.72 922 | 9.99 257 | 3  | 26 | 61.2 60.3 59.4      |
| 35 | 9.26 403 | 67 | 9.27 148 | 70    | 0.72 852 | 9.99 255 | 2  | 25 |                     |
| 36 | 9.26 470 | 68 | 9.27 218 | 70    | 0.72 782 | 9.99 252 | 3  | 24 | 65 3                |
| 37 | 9.26 538 | 67 | 9.27 288 | 69    | 0.72 712 | 9.99 250 | 2  | 23 | 6.5 0.3             |
| 38 | 9.26 605 | 67 | 9.27 357 | 70    | 0.72 643 | 9.99 248 | 2  | 22 | 13.0 0.6            |
| 39 | 9.26 672 | 67 | 9.27 427 | 69    | 0.72 573 | 9.99 245 | 3  | 21 | 19.5 0.9            |
| 40 | 9.26 739 | 67 | 9.27 496 | 70    | 0.72 504 | 9.99 243 | 2  | 20 | 26.0 1.2            |
| 41 | 9.26 806 | 67 | 9.27 566 | 69    | 0.72 434 | 9.99 241 | 3  | 19 | 32.5 1.5            |
| 42 | 9.26 873 | 67 | 9.27 635 | 69    | 0.72 365 | 9.99 238 | 2  | 18 | 39.0 1.8            |
| 43 | 9.26 940 | 67 | 9.27 704 | 69    | 0.72 296 | 9.99 236 | 3  | 17 | 45.5 2.1            |
| 44 | 9.27 007 | 66 | 9.27 773 | 69    | 0.72 227 | 9.99 233 | 2  | 16 | 52.0 2.4            |
| 45 | 9.27 073 | 67 | 9.27 842 | 69    | 0.72 158 | 9.99 231 | 3  | 15 | 58.5 2.7            |
| 46 | 9.27 140 | 66 | 9.27 911 | 69    | 0.72 089 | 9.99 229 | 2  | 14 |                     |
| 47 | 9.27 206 | 67 | 9.27 980 | 69    | 0.72 020 | 9.99 226 | 3  | 13 | 3                   |
| 48 | 9.27 273 | 66 | 9.28 049 | 69    | 0.71 951 | 9.99 224 | 2  | 12 | 8 3 3               |
| 49 | 9.27 339 | 66 | 9.28 117 | 69    | 0.71 883 | 9.99 221 | 3  | 11 | 74 73 72            |
| 50 | 9.27 405 | 66 | 9.28 186 | 68    | 0.71 814 | 9.99 219 | 2  | 10 | 12.3 12.2 12.0      |
| 51 | 9.27 471 | 66 | 9.28 254 | 69    | 0.71 746 | 9.99 217 | 3  | 9  | 37.0 36.5 36.0      |
| 52 | 9.27 537 | 65 | 9.28 323 | 68    | 0.71 677 | 9.99 214 | 2  | 8  | 61.7 60.8 60.0      |
| 53 | 9.27 602 | 66 | 9.28 391 | 68    | 0.71 609 | 9.99 212 | 3  | 7  |                     |
| 54 | 9.27 668 | 66 | 9.28 459 | 68    | 0.71 541 | 9.99 209 | 2  | 6  | 3 3 3 3             |
| 55 | 9.27 734 | 65 | 9.28 527 | 68    | 0.71 473 | 9.99 207 | 3  | 5  | 71 70 69 68         |
| 56 | 9.27 799 | 65 | 9.28 595 | 67    | 0.71 405 | 9.99 204 | 2  | 4  |                     |
| 57 | 9.27 864 | 66 | 9.28 662 | 68    | 0.71 338 | 9.99 202 | 3  | 3  | 11.8 11.7 11.5 11.3 |
| 58 | 9.27 930 | 65 | 9.28 730 | 68    | 0.71 270 | 9.99 200 | 2  | 2  | 35.5 35.0 34.5 34.0 |
| 59 | 9.27 995 | 65 | 9.28 798 | 67    | 0.71 202 | 9.99 197 | 3  | 1  | 59.2 58.3 57.5 56.7 |
| 60 | 9.28 060 | 65 | 9.28 865 | 67    | 0.71 135 | 9.99 195 | 2  | 0  |                     |
|    | L. Cos.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Sin.  | d. |    | P. P.               |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.            |
|----|----------|----|----------|-------|----------|----------|----|----|------------------|
| 0  | 9.28 060 | 65 | 9.28 865 | 68    | 0.71 135 | 9.99 195 | 3  | 60 |                  |
| 1  | 9.28 125 | 65 | 9.28 933 | 67    | 0.71 067 | 9.99 192 | 3  | 59 | 68 67 66         |
| 2  | 9.28 190 | 64 | 9.29 000 | 67    | 0.71 000 | 9.99 190 | 3  | 58 | 1 6.8 6.7 6.6    |
| 3  | 9.28 254 | 64 | 9.29 067 | 67    | 0.70 933 | 9.99 187 | 3  | 57 | 2 13.6 13.4 13.2 |
| 4  | 9.28 319 | 65 | 9.29 134 | 67    | 0.70 866 | 9.99 185 | 3  | 56 | 3 20.4 20.1 19.8 |
| 5  | 9.28 384 | 65 | 9.29 201 | 67    | 0.70 799 | 9.99 182 | 3  | 55 | 4 27.2 26.8 26.4 |
| 6  | 9.28 448 | 64 | 9.29 268 | 67    | 0.70 732 | 9.99 180 | 3  | 54 | 5 34.0 33.5 33.0 |
| 7  | 9.28 512 | 65 | 9.29 335 | 67    | 0.70 665 | 9.99 177 | 3  | 53 | 6 40.8 40.2 39.6 |
| 8  | 9.28 577 | 64 | 9.29 402 | 66    | 0.70 598 | 9.99 175 | 3  | 52 | 7 47.6 46.9 46.2 |
| 9  | 9.28 641 | 64 | 9.29 468 | 67    | 0.70 532 | 9.99 172 | 3  | 51 | 8 54.4 53.6 52.8 |
| 10 | 9.28 705 | 64 | 9.29 535 | 66    | 0.70 465 | 9.99 170 | 3  | 50 | 9 61.2 60.3 59.4 |
| 11 | 9.28 769 | 64 | 9.29 601 | 67    | 0.70 399 | 9.99 167 | 3  | 49 |                  |
| 12 | 9.28 833 | 63 | 9.29 668 | 66    | 0.70 332 | 9.99 165 | 3  | 48 | 65 64 63         |
| 13 | 9.28 896 | 64 | 9.29 734 | 66    | 0.70 266 | 9.99 162 | 3  | 47 | 1 6.5 6.4 6.3    |
| 14 | 9.28 960 | 64 | 9.29 800 | 66    | 0.70 200 | 9.99 160 | 3  | 46 | 2 13.0 12.8 12.6 |
| 15 | 9.29 024 | 63 | 9.29 866 | 66    | 0.70 134 | 9.99 157 | 3  | 45 | 3 19.5 19.2 18.9 |
| 16 | 9.29 087 | 63 | 9.29 932 | 66    | 0.70 068 | 9.99 155 | 3  | 44 | 4 26.0 25.6 25.2 |
| 17 | 9.29 150 | 64 | 9.29 998 | 66    | 0.70 002 | 9.99 152 | 3  | 43 | 5 32.5 32.0 31.5 |
| 18 | 9.29 214 | 63 | 9.30 064 | 66    | 0.69 936 | 9.99 150 | 3  | 42 | 6 39.0 38.4 37.8 |
| 19 | 9.29 277 | 63 | 9.30 130 | 65    | 0.69 870 | 9.99 147 | 3  | 41 | 7 45.5 44.8 44.1 |
| 20 | 9.29 340 | 63 | 9.30 195 | 66    | 0.69 805 | 9.99 145 | 3  | 40 | 8 52.0 51.2 50.4 |
| 21 | 9.29 403 | 63 | 9.30 261 | 65    | 0.69 739 | 9.99 142 | 3  | 39 | 9 58.5 57.6 56.7 |
| 22 | 9.29 466 | 63 | 9.30 326 | 65    | 0.69 674 | 9.99 140 | 3  | 38 |                  |
| 23 | 9.29 529 | 62 | 9.30 391 | 66    | 0.69 609 | 9.99 137 | 3  | 37 | 62 61 60         |
| 24 | 9.29 591 | 63 | 9.30 457 | 65    | 0.69 543 | 9.99 135 | 3  | 36 | 1 6.2 6.1 6.0    |
| 25 | 9.29 654 | 62 | 9.30 522 | 65    | 0.69 478 | 9.99 132 | 3  | 35 | 2 12.4 12.2 12.0 |
| 26 | 9.29 716 | 63 | 9.30 587 | 65    | 0.69 413 | 9.99 130 | 3  | 34 | 3 18.6 18.3 18.0 |
| 27 | 9.29 779 | 62 | 9.30 652 | 65    | 0.69 348 | 9.99 127 | 3  | 33 | 4 24.8 24.4 24.0 |
| 28 | 9.29 841 | 62 | 9.30 717 | 65    | 0.69 283 | 9.99 124 | 3  | 32 | 5 31.0 30.5 30.0 |
| 29 | 9.29 903 | 63 | 9.30 782 | 64    | 0.69 218 | 9.99 122 | 3  | 31 | 6 37.2 36.6 36.0 |
| 30 | 9.29 966 | 62 | 9.30 846 | 65    | 0.69 154 | 9.99 119 | 3  | 30 | 7 43.4 42.7 42.0 |
| 31 | 9.30 028 | 62 | 9.30 911 | 64    | 0.69 089 | 9.99 117 | 3  | 29 | 8 49.6 48.8 48.0 |
| 32 | 9.30 090 | 61 | 9.30 975 | 65    | 0.69 025 | 9.99 114 | 3  | 28 | 9 55.8 54.9 54.0 |
| 33 | 9.30 151 | 62 | 9.31 040 | 64    | 0.68 960 | 9.99 112 | 3  | 27 |                  |
| 34 | 9.30 213 | 62 | 9.31 104 | 64    | 0.68 896 | 9.99 109 | 3  | 26 | 59 8             |
| 35 | 9.30 275 | 61 | 9.31 168 | 65    | 0.68 832 | 9.99 106 | 3  | 25 | 1 5.9 0.3        |
| 36 | 9.30 336 | 62 | 9.31 233 | 64    | 0.68 767 | 9.99 104 | 3  | 24 | 2 11.8 0.6       |
| 37 | 9.30 398 | 61 | 9.31 297 | 64    | 0.68 703 | 9.99 101 | 3  | 23 | 3 17.7 0.9       |
| 38 | 9.30 459 | 62 | 9.31 361 | 64    | 0.68 639 | 9.99 099 | 3  | 22 | 4 23.6 1.2       |
| 39 | 9.30 521 | 61 | 9.31 425 | 64    | 0.68 575 | 9.99 096 | 3  | 21 | 5 29.5 1.5       |
| 40 | 9.30 582 | 61 | 9.31 489 | 63    | 0.68 511 | 9.99 093 | 3  | 20 | 6 35.4 1.8       |
| 41 | 9.30 643 | 61 | 9.31 552 | 64    | 0.68 448 | 9.99 091 | 3  | 19 | 7 41.3 2.1       |
| 42 | 9.30 704 | 61 | 9.31 616 | 63    | 0.68 384 | 9.99 088 | 3  | 18 | 8 47.2 2.4       |
| 43 | 9.30 765 | 61 | 9.31 679 | 64    | 0.68 321 | 9.99 086 | 3  | 17 | 9 53.1 2.7       |
| 44 | 9.30 826 | 61 | 9.31 743 | 63    | 0.68 257 | 9.99 083 | 3  | 16 |                  |
| 45 | 9.30 887 | 60 | 9.31 806 | 64    | 0.68 194 | 9.99 080 | 3  | 15 | 3 3 3            |
| 46 | 9.30 947 | 61 | 9.31 870 | 63    | 0.68 130 | 9.99 078 | 3  | 14 | 67 66 65         |
| 47 | 9.31 008 | 60 | 9.31 933 | 63    | 0.68 067 | 9.99 075 | 3  | 13 | 0 11.2 11.0 10.8 |
| 48 | 9.31 068 | 61 | 9.31 996 | 63    | 0.68 004 | 9.99 072 | 3  | 12 | 1 33.5 33.0 32.5 |
| 49 | 9.31 129 | 60 | 9.32 059 | 63    | 0.67 941 | 9.99 070 | 3  | 11 | 2 55.8 55.0 54.2 |
| 50 | 9.31 189 | 61 | 9.32 122 | 63    | 0.67 878 | 9.99 067 | 3  | 10 |                  |
| 51 | 9.31 250 | 60 | 9.32 185 | 63    | 0.67 815 | 9.99 064 | 3  | 9  |                  |
| 52 | 9.31 310 | 60 | 9.32 248 | 63    | 0.67 752 | 9.99 062 | 3  | 8  |                  |
| 53 | 9.31 370 | 60 | 9.32 311 | 62    | 0.67 689 | 9.99 059 | 3  | 7  | 3 3 3            |
| 54 | 9.31 430 | 60 | 9.32 373 | 63    | 0.67 627 | 9.99 056 | 3  | 6  | 64 63 62         |
| 55 | 9.31 490 | 59 | 9.32 436 | 62    | 0.67 564 | 9.99 054 | 3  | 5  | 0 10.7 10.5 10.3 |
| 56 | 9.31 549 | 60 | 9.32 498 | 63    | 0.67 502 | 9.99 051 | 3  | 4  | 1 32.0 31.5 31.0 |
| 57 | 9.31 609 | 60 | 9.32 561 | 62    | 0.67 439 | 9.99 048 | 3  | 3  | 2 53.3 52.5 51.7 |
| 58 | 9.31 669 | 59 | 9.32 623 | 62    | 0.67 377 | 9.99 046 | 3  | 2  |                  |
| 59 | 9.31 728 | 59 | 9.32 685 | 62    | 0.67 315 | 9.99 043 | 3  | 1  |                  |
| 60 | 9.31 788 | 62 | 9.32 747 | 62    | 0.67 253 | 9.99 040 | 3  | 0  |                  |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Sin.  | d.       |    |    | P. P.            |

|    | L. Sin.  |    | d. | L. Tan.  |       | c. d. | L. Cot.  |         | L. Cos.  |  | d. | P. P. |  |
|----|----------|----|----|----------|-------|-------|----------|---------|----------|--|----|-------|--|
|    |          |    |    |          |       |       |          |         |          |  |    |       |  |
| 0  | 9.31 788 |    |    | 9.32 747 |       | 63    | 0.67 253 |         | 9.99 040 |  | 2  | 60    |  |
| 1  | 9.31 847 | 59 |    | 9.32 810 | 60    | 62    | 0.67 190 |         | 9.99 038 |  | 3  | 59    |  |
| 2  | 9.31 907 | 60 |    | 9.32 872 | 61    | 61    | 0.67 128 |         | 9.99 035 |  | 3  | 58    |  |
| 3  | 9.31 966 | 59 |    | 9.32 933 | 62    | 62    | 0.67 067 |         | 9.99 032 |  | 3  | 57    |  |
| 4  | 9.32 025 | 59 |    | 9.32 995 | 62    | 62    | 0.67 005 |         | 9.99 030 |  | 3  | 56    |  |
| 5  | 9.32 084 | 59 |    | 9.33 057 | 62    | 62    | 0.66 943 |         | 9.99 027 |  | 3  | 55    |  |
| 6  | 9.32 143 | 59 |    | 9.33 119 | 61    | 61    | 0.66 881 |         | 9.99 024 |  | 3  | 54    |  |
| 7  | 9.32 202 | 59 |    | 9.33 180 | 62    | 62    | 0.66 820 |         | 9.99 022 |  | 3  | 53    |  |
| 8  | 9.32 261 | 58 |    | 9.33 242 | 61    | 61    | 0.66 758 |         | 9.99 019 |  | 3  | 52    |  |
| 9  | 9.32 319 | 59 |    | 9.33 303 | 62    | 62    | 0.66 697 |         | 9.99 016 |  | 3  | 51    |  |
| 10 | 9.32 378 | 59 |    | 9.33 365 | 61    | 61    | 0.66 635 |         | 9.99 013 |  | 3  | 50    |  |
| 11 | 9.32 437 | 58 |    | 9.33 426 | 61    | 61    | 0.66 574 |         | 9.99 011 |  | 3  | 49    |  |
| 12 | 9.32 495 | 58 |    | 9.33 487 | 61    | 61    | 0.66 513 |         | 9.99 008 |  | 3  | 48    |  |
| 13 | 9.32 553 | 59 |    | 9.33 548 | 61    | 61    | 0.66 452 |         | 9.99 005 |  | 3  | 47    |  |
| 14 | 9.32 612 | 58 |    | 9.33 609 | 61    | 61    | 0.66 391 |         | 9.99 002 |  | 3  | 46    |  |
| 15 | 9.32 670 | 58 |    | 9.33 670 | 61    | 61    | 0.66 330 |         | 9.99 000 |  | 3  | 45    |  |
| 16 | 9.32 728 | 58 |    | 9.33 731 | 61    | 61    | 0.66 269 |         | 9.98 997 |  | 3  | 44    |  |
| 17 | 9.32 786 | 58 |    | 9.33 792 | 61    | 61    | 0.66 208 |         | 9.98 994 |  | 3  | 43    |  |
| 18 | 9.32 844 | 58 |    | 9.33 853 | 60    | 60    | 0.66 147 |         | 9.98 991 |  | 3  | 42    |  |
| 19 | 9.32 902 | 58 |    | 9.33 913 | 61    | 61    | 0.66 087 |         | 9.98 989 |  | 3  | 41    |  |
| 20 | 9.32 960 | 58 |    | 9.33 974 | 60    | 60    | 0.66 026 |         | 9.98 986 |  | 3  | 40    |  |
| 21 | 9.33 018 | 57 |    | 9.34 034 | 61    | 61    | 0.65 966 |         | 9.98 983 |  | 3  | 39    |  |
| 22 | 9.33 075 | 58 |    | 9.34 095 | 60    | 60    | 0.65 905 |         | 9.98 980 |  | 3  | 38    |  |
| 23 | 9.33 133 | 57 |    | 9.34 155 | 60    | 60    | 0.65 845 |         | 9.98 978 |  | 3  | 37    |  |
| 24 | 9.33 190 | 58 |    | 9.34 215 | 61    | 61    | 0.65 785 |         | 9.98 975 |  | 3  | 36    |  |
| 25 | 9.33 248 | 58 |    | 9.34 276 | 60    | 60    | 0.65 724 |         | 9.98 972 |  | 3  | 35    |  |
| 26 | 9.33 305 | 57 |    | 9.34 336 | 60    | 60    | 0.65 664 |         | 9.98 969 |  | 3  | 34    |  |
| 27 | 9.33 362 | 58 |    | 9.34 396 | 60    | 60    | 0.65 604 |         | 9.98 967 |  | 3  | 33    |  |
| 28 | 9.33 420 | 57 |    | 9.34 456 | 60    | 60    | 0.65 544 |         | 9.98 964 |  | 3  | 32    |  |
| 29 | 9.33 477 | 57 |    | 9.34 516 | 60    | 60    | 0.65 484 |         | 9.98 961 |  | 3  | 31    |  |
| 30 | 9.33 534 | 57 |    | 9.34 576 | 59    | 59    | 0.65 424 |         | 9.98 958 |  | 3  | 30    |  |
| 31 | 9.33 591 | 56 |    | 9.34 635 | 60    | 60    | 0.65 365 |         | 9.98 955 |  | 3  | 29    |  |
| 32 | 9.33 647 | 57 |    | 9.34 695 | 60    | 60    | 0.65 305 |         | 9.98 953 |  | 3  | 28    |  |
| 33 | 9.33 704 | 57 |    | 9.34 755 | 59    | 59    | 0.65 245 |         | 9.98 950 |  | 3  | 27    |  |
| 34 | 9.33 761 | 57 |    | 9.34 814 | 60    | 60    | 0.65 186 |         | 9.98 947 |  | 3  | 26    |  |
| 35 | 9.33 818 | 57 |    | 9.34 874 | 59    | 59    | 0.65 126 |         | 9.98 944 |  | 3  | 25    |  |
| 36 | 9.33 874 | 56 |    | 9.34 933 | 59    | 59    | 0.65 067 |         | 9.98 941 |  | 3  | 24    |  |
| 37 | 9.33 931 | 56 |    | 9.34 992 | 59    | 59    | 0.65 008 |         | 9.98 938 |  | 3  | 23    |  |
| 38 | 9.33 987 | 56 |    | 9.35 051 | 60    | 60    | 0.64 949 |         | 9.98 936 |  | 3  | 22    |  |
| 39 | 9.34 043 | 57 |    | 9.35 111 | 59    | 59    | 0.64 889 |         | 9.98 933 |  | 3  | 21    |  |
| 40 | 9.34 100 | 56 |    | 9.35 170 | 59    | 59    | 0.64 830 |         | 9.98 930 |  | 3  | 20    |  |
| 41 | 9.34 156 | 56 |    | 9.35 229 | 59    | 59    | 0.64 771 |         | 9.98 927 |  | 3  | 19    |  |
| 42 | 9.34 212 | 56 |    | 9.35 288 | 59    | 59    | 0.64 712 |         | 9.98 924 |  | 3  | 18    |  |
| 43 | 9.34 268 | 56 |    | 9.35 347 | 58    | 58    | 0.64 653 |         | 9.98 921 |  | 3  | 17    |  |
| 44 | 9.34 324 | 56 |    | 9.35 405 | 59    | 59    | 0.64 595 |         | 9.98 919 |  | 3  | 16    |  |
| 45 | 9.34 380 | 56 |    | 9.35 464 | 59    | 59    | 0.64 536 |         | 9.98 916 |  | 3  | 15    |  |
| 46 | 9.34 436 | 55 |    | 9.35 523 | 58    | 58    | 0.64 477 |         | 9.98 913 |  | 3  | 14    |  |
| 47 | 9.34 491 | 55 |    | 9.35 581 | 58    | 58    | 0.64 419 |         | 9.98 910 |  | 3  | 13    |  |
| 48 | 9.34 547 | 55 |    | 9.35 640 | 59    | 59    | 0.64 360 |         | 9.98 907 |  | 3  | 12    |  |
| 49 | 9.34 602 | 56 |    | 9.35 698 | 59    | 59    | 0.64 302 |         | 9.98 904 |  | 3  | 11    |  |
| 50 | 9.34 658 | 56 |    | 9.35 757 | 58    | 58    | 0.64 243 |         | 9.98 901 |  | 3  | 10    |  |
| 51 | 9.34 713 | 55 |    | 9.35 815 | 58    | 58    | 0.64 185 |         | 9.98 898 |  | 3  | 9     |  |
| 52 | 9.34 769 | 55 |    | 9.35 873 | 58    | 58    | 0.64 127 |         | 9.98 896 |  | 3  | 8     |  |
| 53 | 9.34 824 | 55 |    | 9.35 931 | 58    | 58    | 0.64 069 |         | 9.98 893 |  | 3  | 7     |  |
| 54 | 9.34 879 | 55 |    | 9.35 989 | 58    | 58    | 0.64 011 |         | 9.98 890 |  | 3  | 6     |  |
| 55 | 9.34 934 | 55 |    | 9.36 047 | 58    | 58    | 0.63 953 |         | 9.98 887 |  | 3  | 5     |  |
| 56 | 9.34 989 | 55 |    | 9.36 105 | 58    | 58    | 0.63 895 |         | 9.98 884 |  | 3  | 4     |  |
| 57 | 9.35 044 | 55 |    | 9.36 163 | 58    | 58    | 0.63 837 |         | 9.98 881 |  | 3  | 3     |  |
| 58 | 9.35 099 | 55 |    | 9.36 221 | 58    | 58    | 0.63 779 |         | 9.98 878 |  | 3  | 2     |  |
| 59 | 9.35 154 | 55 |    | 9.36 279 | 57    | 57    | 0.63 721 |         | 9.98 875 |  | 3  | 1     |  |
| 60 | 9.35 209 | 55 |    | 9.36 336 |       |       | 0.63 664 |         | 9.98 872 |  | 3  | 0     |  |
|    | L. Cos.  | d. |    | L. Cot.  | c. d. |       | L. Tan.  | L. Sin. | d.       |  |    | P. P. |  |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. | P. P. |
|----|----------|----|----------|-------|----------|----------|----|-------|
| 0  | 9.35 209 | 54 | 9.36 336 | 58    | 0.63 664 | 9.98 872 | 3  | 60    |
| 1  | 9.35 263 | 55 | 9.36 394 | 58    | 0.63 666 | 9.98 869 | 3  | 59    |
| 2  | 9.35 318 | 55 | 9.36 452 | 57    | 0.63 548 | 9.98 867 | 2  | 58    |
| 3  | 9.35 373 | 54 | 9.36 509 | 57    | 0.63 491 | 9.98 864 | 3  | 57    |
| 4  | 9.35 427 | 54 | 9.36 566 | 57    | 0.63 434 | 9.98 861 | 3  | 56    |
| 5  | 9.35 481 | 55 | 9.36 624 | 57    | 0.63 376 | 9.98 858 | 3  | 55    |
| 6  | 9.35 536 | 55 | 9.36 681 | 57    | 0.63 319 | 9.98 855 | 3  | 54    |
| 7  | 9.35 590 | 54 | 9.36 738 | 57    | 0.63 262 | 9.98 852 | 3  | 53    |
| 8  | 9.35 644 | 54 | 9.36 795 | 57    | 0.63 205 | 9.98 849 | 3  | 52    |
| 9  | 9.35 698 | 54 | 9.36 852 | 57    | 0.63 148 | 9.98 846 | 3  | 51    |
| 10 | 9.35 752 | 54 | 9.36 909 | 57    | 0.63 091 | 9.98 843 | 3  | 50    |
| 11 | 9.35 806 | 54 | 9.36 966 | 57    | 0.63 034 | 9.98 840 | 3  | 49    |
| 12 | 9.35 860 | 54 | 9.37 023 | 57    | 0.62 977 | 9.98 837 | 3  | 48    |
| 13 | 9.35 914 | 54 | 9.37 080 | 57    | 0.62 920 | 9.98 834 | 3  | 47    |
| 14 | 9.35 968 | 54 | 9.37 137 | 56    | 0.62 863 | 9.98 831 | 3  | 46    |
| 15 | 9.36 022 | 53 | 9.37 193 | 57    | 0.62 807 | 9.98 828 | 3  | 45    |
| 16 | 9.36 075 | 53 | 9.37 250 | 57    | 0.62 750 | 9.98 825 | 3  | 44    |
| 17 | 9.36 129 | 54 | 9.37 306 | 56    | 0.62 694 | 9.98 822 | 3  | 43    |
| 18 | 9.36 182 | 53 | 9.37 363 | 57    | 0.62 637 | 9.98 819 | 3  | 42    |
| 19 | 9.36 236 | 54 | 9.37 419 | 56    | 0.62 581 | 9.98 816 | 3  | 41    |
| 20 | 9.36 289 | 53 | 9.37 476 | 57    | 0.62 524 | 9.98 813 | 3  | 40    |
| 21 | 9.36 342 | 53 | 9.37 532 | 56    | 0.62 468 | 9.98 810 | 3  | 39    |
| 22 | 9.36 395 | 54 | 9.37 588 | 56    | 0.62 412 | 9.98 807 | 3  | 38    |
| 23 | 9.36 449 | 54 | 9.37 644 | 56    | 0.62 356 | 9.98 804 | 3  | 37    |
| 24 | 9.36 502 | 53 | 9.37 700 | 56    | 0.62 300 | 9.98 801 | 3  | 36    |
| 25 | 9.36 555 | 53 | 9.37 756 | 56    | 0.62 244 | 9.98 798 | 3  | 35    |
| 26 | 9.36 608 | 53 | 9.37 812 | 56    | 0.62 188 | 9.98 795 | 3  | 34    |
| 27 | 9.36 660 | 52 | 9.37 868 | 56    | 0.62 132 | 9.98 792 | 3  | 33    |
| 28 | 9.36 713 | 53 | 9.37 924 | 56    | 0.62 076 | 9.98 789 | 3  | 32    |
| 29 | 9.36 766 | 53 | 9.37 980 | 55    | 0.62 020 | 9.98 786 | 3  | 31    |
| 30 | 9.36 819 | 52 | 9.38 035 | 55    | 0.61 965 | 9.98 783 | 3  | 30    |
| 31 | 9.36 871 | 52 | 9.38 091 | 56    | 0.61 909 | 9.98 780 | 3  | 29    |
| 32 | 9.36 924 | 53 | 9.38 147 | 56    | 0.61 853 | 9.98 777 | 3  | 28    |
| 33 | 9.36 976 | 52 | 9.38 202 | 55    | 0.61 798 | 9.98 774 | 3  | 27    |
| 34 | 9.37 028 | 53 | 9.38 257 | 56    | 0.61 743 | 9.98 771 | 3  | 26    |
| 35 | 9.37 081 | 52 | 9.38 313 | 55    | 0.61 687 | 9.98 768 | 3  | 25    |
| 36 | 9.37 133 | 52 | 9.38 368 | 55    | 0.61 632 | 9.98 765 | 3  | 24    |
| 37 | 9.37 185 | 52 | 9.38 423 | 55    | 0.61 577 | 9.98 762 | 3  | 23    |
| 38 | 9.37 237 | 52 | 9.38 479 | 55    | 0.61 521 | 9.98 759 | 3  | 22    |
| 39 | 9.37 289 | 52 | 9.38 534 | 55    | 0.61 466 | 9.98 756 | 3  | 21    |
| 40 | 9.37 341 | 52 | 9.38 589 | 55    | 0.61 411 | 9.98 753 | 3  | 20    |
| 41 | 9.37 393 | 52 | 9.38 644 | 55    | 0.61 356 | 9.98 750 | 3  | 19    |
| 42 | 9.37 445 | 52 | 9.38 699 | 55    | 0.61 301 | 9.98 746 | 4  | 18    |
| 43 | 9.37 497 | 52 | 9.38 754 | 54    | 0.61 246 | 9.98 743 | 3  | 17    |
| 44 | 9.37 549 | 51 | 9.38 808 | 55    | 0.61 192 | 9.98 740 | 3  | 16    |
| 45 | 9.37 600 | 52 | 9.38 863 | 55    | 0.61 137 | 9.98 737 | 3  | 15    |
| 46 | 9.37 652 | 52 | 9.38 918 | 55    | 0.61 082 | 9.98 734 | 3  | 14    |
| 47 | 9.37 703 | 51 | 9.38 972 | 54    | 0.61 028 | 9.98 731 | 3  | 13    |
| 48 | 9.37 755 | 52 | 9.39 027 | 55    | 0.60 973 | 9.98 728 | 3  | 12    |
| 49 | 9.37 806 | 51 | 9.39 082 | 55    | 0.60 918 | 9.98 725 | 3  | 11    |
| 50 | 9.37 858 | 51 | 9.39 136 | 54    | 0.60 864 | 9.98 722 | 3  | 10    |
| 51 | 9.37 909 | 51 | 9.39 190 | 54    | 0.60 810 | 9.98 719 | 3  | 9     |
| 52 | 9.37 960 | 51 | 9.39 245 | 55    | 0.60 755 | 9.98 715 | 4  | 8     |
| 53 | 9.38 011 | 51 | 9.39 299 | 54    | 0.60 701 | 9.98 712 | 3  | 7     |
| 54 | 9.38 062 | 51 | 9.39 353 | 54    | 0.60 647 | 9.98 709 | 3  | 6     |
| 55 | 9.38 113 | 51 | 9.39 407 | 54    | 0.60 593 | 9.98 706 | 3  | 5     |
| 56 | 9.38 164 | 51 | 9.39 461 | 54    | 0.60 539 | 9.98 703 | 3  | 4     |
| 57 | 9.38 215 | 51 | 9.39 515 | 54    | 0.60 485 | 9.98 700 | 3  | 3     |
| 58 | 9.38 266 | 51 | 9.39 569 | 54    | 0.60 431 | 9.98 697 | 3  | 2     |
| 59 | 9.38 317 | 51 | 9.39 623 | 54    | 0.60 377 | 9.98 694 | 3  | 1     |
| 60 | 9.38 368 | 51 | 9.39 677 | 54    | 0.60 323 | 9.98 690 | 3  | 0     |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. | P. P. |

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5.8 5.7 5.6

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17.4 17.1 16.8

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40.6 39.9 39.2

46.4 45.6 44.8

52.2 51.3 50.4

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11.0 10.8 10.6

16.5 16.2 15.9

22.0 21.6 21.2

27.5 27.0 26.5

33.0 32.4 31.8

38.5 37.8 37.1

44.0 43.2 42.4

49.5 48.6 47.7

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| L. Sin. |          | d. | L. Tan.  |       | c. d. | L. Cot.  |          | L. Cos. | d. | P. P. |                |
|---------|----------|----|----------|-------|-------|----------|----------|---------|----|-------|----------------|
| 0       | 9.38 368 | 50 | 9.39 677 | 54    |       | 0.60 323 | 9.98 690 |         | 60 |       |                |
| 1       | 9.38 418 | 51 | 9.39 731 | 54    |       | 0.60 269 | 9.98 687 | 3       | 59 | 54    | 53             |
| 2       | 9.38 469 | 50 | 9.39 783 | 53    |       | 0.60 215 | 9.98 684 | 3       | 58 |       |                |
| 3       | 9.38 519 | 51 | 9.39 838 | 54    |       | 0.60 162 | 9.98 681 | 3       | 57 | 1     | 5.4 5.3        |
| 4       | 9.38 570 | 50 | 9.39 892 | 53    |       | 0.60 108 | 9.98 678 | 3       | 56 | 2     | 10.8 10.6      |
| 5       | 9.38 620 | 50 | 9.39 945 | 54    |       | 0.60 055 | 9.98 675 | 3       | 55 | 3     | 16.2 15.9      |
| 6       | 9.38 670 | 51 | 9.39 999 | 54    |       | 0.60 001 | 9.98 671 | 3       | 54 | 4     | 21.6 21.2      |
| 7       | 9.38 721 | 50 | 9.40 052 | 53    |       | 0.59 948 | 9.98 668 | 3       | 53 | 5     | 27.0 26.5      |
| 8       | 9.38 771 | 50 | 9.40 106 | 54    |       | 0.59 894 | 9.98 665 | 3       | 52 | 6     | 32.4 31.8      |
| 9       | 9.38 821 | 50 | 9.40 159 | 53    |       | 0.59 841 | 9.98 662 | 3       | 51 | 7     | 37.8 37.1      |
| 10      | 9.38 871 | 50 | 9.40 212 | 53    |       | 0.59 788 | 9.98 659 | 3       | 50 | 8     | 43.2 42.4      |
| 11      | 9.38 921 | 50 | 9.40 266 | 54    |       | 0.59 734 | 9.98 656 | 3       | 49 | 9     | 48.6 47.7      |
| 12      | 9.38 971 | 50 | 9.40 319 | 53    |       | 0.59 681 | 9.98 652 | 3       | 48 |       |                |
| 13      | 9.39 021 | 50 | 9.40 372 | 53    |       | 0.59 628 | 9.98 649 | 3       | 47 | 52    | 51 50          |
| 14      | 9.39 071 | 50 | 9.40 425 | 53    |       | 0.59 575 | 9.98 646 | 3       | 46 | 1     | 5.2 5.1 5.0    |
| 15      | 9.39 121 | 49 | 9.40 478 | 53    |       | 0.59 522 | 9.98 643 | 3       | 45 | 2     | 10.4 10.2 10.0 |
| 16      | 9.39 170 | 50 | 9.40 531 | 53    |       | 0.59 469 | 9.98 640 | 3       | 44 | 3     | 15.6 15.3 15.0 |
| 17      | 9.39 220 | 50 | 9.40 584 | 52    |       | 0.59 416 | 9.98 636 | 3       | 43 | 4     | 20.8 20.4 20.0 |
| 18      | 9.39 270 | 49 | 9.40 636 | 52    |       | 0.59 364 | 9.98 633 | 3       | 42 | 5     | 26.0 25.5 25.0 |
| 19      | 9.39 319 | 50 | 9.40 689 | 53    |       | 0.59 311 | 9.98 630 | 3       | 41 | 6     | 31.2 30.6 30.0 |
| 20      | 9.39 369 | 49 | 9.40 742 | 53    |       | 0.59 258 | 9.98 627 | 3       | 40 | 7     | 36.4 35.7 35.0 |
| 21      | 9.39 418 | 49 | 9.40 795 | 52    |       | 0.59 205 | 9.98 623 | 3       | 39 | 8     | 41.6 40.8 40.0 |
| 22      | 9.39 467 | 50 | 9.40 847 | 53    |       | 0.59 153 | 9.98 620 | 3       | 38 | 9     | 46.8 45.9 45.0 |
| 23      | 9.39 517 | 49 | 9.40 900 | 52    |       | 0.59 100 | 9.98 617 | 3       | 37 |       |                |
| 24      | 9.39 566 | 49 | 9.40 952 | 53    |       | 0.59 048 | 9.98 614 | 3       | 36 | 49    | 48 47          |
| 25      | 9.39 615 | 49 | 9.41 005 | 52    |       | 0.58 995 | 9.98 610 | 3       | 35 | 1     | 4.9 4.8 4.7    |
| 26      | 9.39 664 | 49 | 9.41 057 | 52    |       | 0.58 943 | 9.98 607 | 3       | 34 | 2     | 9.8 9.6 9.4    |
| 27      | 9.39 713 | 49 | 9.41 109 | 52    |       | 0.58 891 | 9.98 604 | 3       | 33 | 3     | 14.7 14.4 14.1 |
| 28      | 9.39 762 | 49 | 9.41 161 | 53    |       | 0.58 839 | 9.98 601 | 3       | 32 | 4     | 19.6 19.2 18.8 |
| 29      | 9.39 811 | 49 | 9.41 214 | 52    |       | 0.58 786 | 9.98 597 | 3       | 31 | 5     | 24.5 24.0 23.5 |
| 30      | 9.39 860 | 49 | 9.41 266 | 52    |       | 0.58 734 | 9.98 594 | 3       | 30 | 6     | 29.4 28.8 28.2 |
| 31      | 9.39 909 | 49 | 9.41 318 | 52    |       | 0.58 682 | 9.98 591 | 3       | 29 | 7     | 34.3 33.6 32.9 |
| 32      | 9.39 958 | 48 | 9.41 370 | 52    |       | 0.58 630 | 9.98 588 | 3       | 28 | 8     | 39.2 38.4 37.6 |
| 33      | 9.40 006 | 49 | 9.41 422 | 52    |       | 0.58 578 | 9.98 584 | 3       | 27 | 9     | 44.1 43.2 42.3 |
| 34      | 9.40 055 | 48 | 9.41 474 | 52    |       | 0.58 526 | 9.98 581 | 3       | 26 |       |                |
| 35      | 9.40 103 | 49 | 9.41 526 | 52    |       | 0.58 474 | 9.98 578 | 3       | 25 | 4     | 3              |
| 36      | 9.40 152 | 48 | 9.41 578 | 51    |       | 0.58 422 | 9.98 574 | 3       | 24 | 1     | 0.4 0.3        |
| 37      | 9.40 200 | 49 | 9.41 629 | 52    |       | 0.58 371 | 9.98 571 | 3       | 23 | 2     | 0.8 0.6        |
| 38      | 9.40 249 | 48 | 9.41 681 | 52    |       | 0.58 319 | 9.98 568 | 3       | 22 | 3     | 1.2 0.9        |
| 39      | 9.40 297 | 49 | 9.41 733 | 51    |       | 0.58 267 | 9.98 565 | 3       | 21 | 4     | 1.6 1.2        |
| 40      | 9.40 346 | 48 | 9.41 784 | 52    |       | 0.58 216 | 9.98 561 | 3       | 20 | 5     | 2.0 1.5        |
| 41      | 9.40 394 | 48 | 9.41 836 | 51    |       | 0.58 164 | 9.98 558 | 3       | 19 | 6     | 2.4 1.8        |
| 42      | 9.40 442 | 48 | 9.41 887 | 52    |       | 0.58 113 | 9.98 555 | 3       | 18 | 7     | 2.8 2.1        |
| 43      | 9.40 490 | 48 | 9.41 939 | 51    |       | 0.58 061 | 9.98 551 | 3       | 17 | 8     | 3.2 2.4        |
| 44      | 9.40 538 | 48 | 9.41 990 | 51    |       | 0.58 010 | 9.98 548 | 3       | 16 | 9     | 3.6 2.7        |
| 45      | 9.40 586 | 48 | 9.42 041 | 51    |       | 0.57 959 | 9.98 545 | 3       | 15 |       |                |
| 46      | 9.40 634 | 48 | 9.42 093 | 52    |       | 0.57 907 | 9.98 541 | 3       | 14 | 1     | 0.4 0.3        |
| 47      | 9.40 682 | 48 | 9.42 144 | 51    |       | 0.57 856 | 9.98 538 | 3       | 13 | 2     | 0.8 0.6        |
| 48      | 9.40 730 | 48 | 9.42 195 | 51    |       | 0.57 805 | 9.98 535 | 3       | 12 | 3     | 1.2 0.9        |
| 49      | 9.40 778 | 47 | 9.42 246 | 51    |       | 0.57 754 | 9.98 531 | 3       | 11 | 4     | 1.6 1.2        |
| 50      | 9.40 825 | 48 | 9.42 297 | 51    |       | 0.57 703 | 9.98 528 | 3       | 10 | 5     | 2.0 1.5        |
| 51      | 9.40 873 | 48 | 9.42 348 | 51    |       | 0.57 652 | 9.98 525 | 3       | 9  | 6     | 2.4 1.8        |
| 52      | 9.40 921 | 47 | 9.42 399 | 51    |       | 0.57 601 | 9.98 521 | 3       | 8  | 7     | 2.8 2.1        |
| 53      | 9.40 968 | 48 | 9.42 450 | 51    |       | 0.57 550 | 9.98 518 | 3       | 7  | 8     | 3.2 2.4        |
| 54      | 9.41 016 | 47 | 9.42 501 | 51    |       | 0.57 499 | 9.98 515 | 3       | 6  | 9     | 3.6 2.7        |
| 55      | 9.41 063 | 48 | 9.42 552 | 51    |       | 0.57 448 | 9.98 511 | 3       | 5  |       |                |
| 56      | 9.41 111 | 47 | 9.42 603 | 50    |       | 0.57 397 | 9.98 508 | 3       | 4  | 1     | 0.4 0.3        |
| 57      | 9.41 158 | 47 | 9.42 653 | 51    |       | 0.57 347 | 9.98 505 | 3       | 3  | 2     | 0.8 0.6        |
| 58      | 9.41 205 | 47 | 9.42 704 | 51    |       | 0.57 296 | 9.98 501 | 3       | 2  | 3     | 1.2 0.9        |
| 59      | 9.41 252 | 48 | 9.42 755 | 50    |       | 0.57 245 | 9.98 498 | 3       | 1  | 4     | 1.6 1.2        |
| 60      | 9.41 300 |    | 9.42 805 |       |       | 0.57 195 | 9.98 494 | 3       | 0  | 5     | 2.0 1.5        |
|         | L. Cos.  | d. | L. Cot.  | c. d. |       | L. Tan.  | L. Sin.  | d.      |    |       | P. P.          |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.                 |
|----|----------|----|----------|-------|----------|----------|----|----|-----------------------|
| 0  | 9.41 300 | 47 | 9.42 805 | 51    | 0.57 195 | 9.98 494 | 3  | 60 |                       |
| 1  | 9.41 347 | 47 | 9.42 856 | 50    | 0.57 144 | 9.98 491 | 3  | 59 | 51 50 49              |
| 2  | 9.41 394 | 47 | 9.42 906 | 51    | 0.57 094 | 9.98 488 | 3  | 58 |                       |
| 3  | 9.41 441 | 47 | 9.42 957 | 50    | 0.57 043 | 9.98 484 | 3  | 57 | I 5.1 5.0 4.9         |
| 4  | 9.41 488 | 47 | 9.43 007 | 50    | 0.56 993 | 9.98 481 | 3  | 56 | 2 10.2 10.0 9.8       |
| 5  | 9.41 535 | 47 | 9.43 057 | 51    | 0.56 943 | 9.98 477 | 3  | 55 | 3 15.3 15.0 14.7      |
| 6  | 9.41 582 | 46 | 9.43 108 | 50    | 0.56 892 | 9.98 474 | 3  | 54 | 4 20.4 20.0 19.6      |
| 7  | 9.41 628 | 47 | 9.43 158 | 50    | 0.56 842 | 9.98 471 | 3  | 53 | 5 25.5 25.0 24.5      |
| 8  | 9.41 675 | 47 | 9.43 208 | 50    | 0.56 792 | 9.98 467 | 3  | 52 | 6 30.6 30.0 29.4      |
| 9  | 9.41 722 | 46 | 9.43 258 | 50    | 0.56 742 | 9.98 464 | 3  | 51 | 7 35.7 35.0 34.3      |
| 10 | 9.41 768 | 47 | 9.43 308 | 50    | 0.56 692 | 9.98 460 | 3  | 50 | 8 40.8 40.0 39.2      |
| 11 | 9.41 815 | 46 | 9.43 358 | 50    | 0.56 642 | 9.98 457 | 3  | 49 | 9 45.9 45.0 44.1      |
| 12 | 9.41 861 | 47 | 9.43 408 | 50    | 0.56 592 | 9.98 453 | 3  | 48 |                       |
| 13 | 9.41 908 | 46 | 9.43 458 | 50    | 0.56 542 | 9.98 450 | 3  | 47 | 48 47 46              |
| 14 | 9.41 954 | 47 | 9.43 508 | 50    | 0.56 492 | 9.98 447 | 3  | 46 | I 4.8 4.7 4.6         |
| 15 | 9.42 001 | 46 | 9.43 558 | 49    | 0.56 442 | 9.98 443 | 3  | 45 | 2 9.6 9.4 9.2         |
| 16 | 9.42 047 | 46 | 9.43 607 | 50    | 0.56 393 | 9.98 440 | 3  | 44 | 3 14.4 14.1 13.8      |
| 17 | 9.42 093 | 47 | 9.43 657 | 50    | 0.56 343 | 9.98 436 | 3  | 43 | 4 19.2 18.8 18.4      |
| 18 | 9.42 140 | 46 | 9.43 707 | 49    | 0.56 293 | 9.98 433 | 3  | 42 | 5 24.0 23.5 23.0      |
| 19 | 9.42 186 | 46 | 9.43 756 | 50    | 0.56 244 | 9.98 429 | 3  | 41 | 6 28.8 28.2 27.6      |
| 20 | 9.42 232 | 46 | 9.43 806 | 49    | 0.56 194 | 9.98 426 | 3  | 40 | 7 33.6 32.9 32.2      |
| 21 | 9.42 278 | 46 | 9.43 855 | 50    | 0.56 145 | 9.98 422 | 3  | 39 | 8 38.4 37.6 36.8      |
| 22 | 9.42 324 | 46 | 9.43 905 | 49    | 0.56 095 | 9.98 419 | 3  | 38 | 9 43.2 42.3 41.4      |
| 23 | 9.42 370 | 46 | 9.43 954 | 50    | 0.56 046 | 9.98 415 | 3  | 37 |                       |
| 24 | 9.42 416 | 46 | 9.44 004 | 49    | 0.55 996 | 9.98 412 | 3  | 36 | 45 44                 |
| 25 | 9.42 461 | 46 | 9.44 053 | 49    | 0.55 947 | 9.98 409 | 3  | 35 | I 4.5 4.4             |
| 26 | 9.42 507 | 46 | 9.44 102 | 49    | 0.55 898 | 9.98 405 | 3  | 34 | 2 9.0 8.8             |
| 27 | 9.42 553 | 46 | 9.44 151 | 50    | 0.55 849 | 9.98 402 | 3  | 33 | 3 13.5 13.2           |
| 28 | 9.42 599 | 45 | 9.44 201 | 49    | 0.55 799 | 9.98 398 | 3  | 32 | 4 18.0 17.6           |
| 29 | 9.42 644 | 45 | 9.44 250 | 49    | 0.55 750 | 9.98 395 | 3  | 31 | 5 22.5 22.0           |
| 30 | 9.42 690 | 45 | 9.44 299 | 49    | 0.55 701 | 9.98 391 | 3  | 30 | 6 27.0 26.4           |
| 31 | 9.42 735 | 46 | 9.44 348 | 49    | 0.55 652 | 9.98 388 | 3  | 29 | 7 31.5 30.8           |
| 32 | 9.42 781 | 46 | 9.44 397 | 49    | 0.55 603 | 9.98 384 | 3  | 28 | 8 36.0 35.2           |
| 33 | 9.42 826 | 46 | 9.44 446 | 49    | 0.55 554 | 9.98 381 | 3  | 27 | 9 40.5 39.6           |
| 34 | 9.42 872 | 46 | 9.44 495 | 49    | 0.55 505 | 9.98 377 | 3  | 26 |                       |
| 35 | 9.42 917 | 45 | 9.44 544 | 48    | 0.55 456 | 9.98 373 | 3  | 25 | 4 3                   |
| 36 | 9.42 962 | 46 | 9.44 592 | 49    | 0.55 408 | 9.98 370 | 3  | 24 | I 0.4 0.3             |
| 37 | 9.43 008 | 45 | 9.44 641 | 49    | 0.55 359 | 9.98 366 | 3  | 23 | 2 0.8 0.6             |
| 38 | 9.43 053 | 45 | 9.44 690 | 48    | 0.55 310 | 9.98 363 | 3  | 22 | 3 1.2 0.9             |
| 39 | 9.43 098 | 45 | 9.44 738 | 49    | 0.55 262 | 9.98 359 | 3  | 21 | 4 1.6 1.2             |
| 40 | 9.43 143 | 45 | 9.44 787 | 49    | 0.55 213 | 9.98 356 | 3  | 20 | 5 2.0 1.5             |
| 41 | 9.43 188 | 45 | 9.44 836 | 48    | 0.55 164 | 9.98 352 | 3  | 19 | 6 2.4 1.8             |
| 42 | 9.43 233 | 45 | 9.44 884 | 49    | 0.55 116 | 9.98 349 | 3  | 18 | 7 2.8 2.1             |
| 43 | 9.43 278 | 45 | 9.44 933 | 48    | 0.55 067 | 9.98 345 | 3  | 17 | 8 3.2 2.4             |
| 44 | 9.43 323 | 45 | 9.44 981 | 48    | 0.55 019 | 9.98 342 | 3  | 16 | 9 3.6 2.7             |
| 45 | 9.43 367 | 44 | 9.45 029 | 48    | 0.54 971 | 9.98 338 | 3  | 15 |                       |
| 46 | 9.43 412 | 45 | 9.45 078 | 48    | 0.54 922 | 9.98 334 | 3  | 14 | 4 4 4 4               |
| 47 | 9.43 457 | 45 | 9.45 126 | 48    | 0.54 874 | 9.98 331 | 3  | 13 | 50 49 48 47           |
| 48 | 9.43 502 | 44 | 9.45 174 | 48    | 0.54 826 | 9.98 327 | 3  | 12 | O 6.2 6.1 6.0 5.9     |
| 49 | 9.43 546 | 44 | 9.45 222 | 49    | 0.54 778 | 9.98 324 | 3  | 11 | I 18.8 18.4 18.0 17.6 |
| 50 | 9.43 591 | 44 | 9.45 271 | 48    | 0.54 729 | 9.98 320 | 3  | 10 | 2 31.2 30.6 30.0 29.4 |
| 51 | 9.43 635 | 45 | 9.45 319 | 48    | 0.54 681 | 9.98 317 | 3  | 9  | 3 43.8 42.9 42.0 41.1 |
| 52 | 9.43 680 | 44 | 9.45 367 | 48    | 0.54 633 | 9.98 313 | 3  | 8  |                       |
| 53 | 9.43 724 | 44 | 9.45 415 | 48    | 0.54 585 | 9.98 309 | 3  | 7  | 3 3 3 3               |
| 54 | 9.43 769 | 45 | 9.45 463 | 48    | 0.54 537 | 9.98 306 | 3  | 6  | 51 50 49 48           |
| 55 | 9.43 813 | 44 | 9.45 511 | 48    | 0.54 489 | 9.98 302 | 3  | 5  | O 8.5 8.3 8.2 8.0     |
| 56 | 9.43 857 | 44 | 9.45 559 | 47    | 0.54 441 | 9.98 299 | 3  | 4  | I 25.5 25.0 24.5 24.0 |
| 57 | 9.43 901 | 45 | 9.45 606 | 48    | 0.54 394 | 9.98 295 | 3  | 3  | 2 42.5 41.7 40.8 40.0 |
| 58 | 9.43 946 | 44 | 9.45 654 | 48    | 0.54 346 | 9.98 291 | 3  | 2  |                       |
| 59 | 9.43 990 | 44 | 9.45 702 | 48    | 0.54 298 | 9.98 288 | 3  | 1  |                       |
| 60 | 9.44 034 | 44 | 9.45 750 | 48    | 0.54 250 | 9.98 284 | 3  | 0  |                       |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P.                 |



|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. | P. P.                 |
|----|----------|----|----------|-------|----------|----------|----|-----------------------|
| 0  | 9.44 034 |    | 9.45 750 |       | 0.54 250 | 9.98 284 | 60 |                       |
| 1  | 9.44 078 | 44 | 9.45 797 | 47    | 0.54 203 | 9.98 281 | 3  |                       |
| 2  | 9.44 122 | 44 | 9.45 845 | 48    | 0.54 155 | 9.98 277 | 4  | 48 47 46              |
| 3  | 9.44 166 | 44 | 9.45 892 | 48    | 0.54 108 | 9.98 273 | 5  |                       |
| 4  | 9.44 210 | 44 | 9.45 940 | 47    | 0.54 060 | 9.98 270 | 3  | 1 4.8 4.7 4.6         |
| 5  | 9.44 253 | 43 | 9.45 987 | 47    | 0.54 013 | 9.98 266 | 4  | 2 9.6 9.4 9.2         |
| 6  | 9.44 297 | 44 | 9.46 035 | 48    | 0.53 965 | 9.98 262 | 5  | 3 14.4 14.1 13.8      |
| 7  | 9.44 341 | 44 | 9.46 082 | 47    | 0.53 918 | 9.98 259 | 4  | 4 19.2 18.8 18.4      |
| 8  | 9.44 385 | 44 | 9.46 130 | 47    | 0.53 870 | 9.98 255 | 3  | 5 24.0 23.5 23.0      |
| 9  | 9.44 428 | 44 | 9.46 177 | 47    | 0.53 823 | 9.98 251 | 4  | 6 28.8 28.2 27.6      |
| 10 | 9.44 472 | 44 | 9.46 224 | 47    | 0.53 776 | 9.98 248 | 5  | 7 33.6 32.9 32.2      |
| 11 | 9.44 516 | 44 | 9.46 271 | 47    | 0.53 729 | 9.98 244 | 6  | 8 38.4 37.6 36.8      |
| 12 | 9.44 559 | 43 | 9.46 319 | 48    | 0.53 681 | 9.98 240 | 7  | 9 43.2 42.3 41.4      |
| 13 | 9.44 602 | 43 | 9.46 366 | 47    | 0.53 634 | 9.98 237 | 4  | 45 44 43              |
| 14 | 9.44 646 | 44 | 9.46 413 | 47    | 0.53 587 | 9.98 233 | 3  |                       |
| 15 | 9.44 689 | 43 | 9.46 460 | 47    | 0.53 540 | 9.98 229 | 4  | 1 4.5 4.4 4.3         |
| 16 | 9.44 733 | 44 | 9.46 507 | 47    | 0.53 493 | 9.98 226 | 5  | 2 9.0 8.8 8.6         |
| 17 | 9.44 776 | 43 | 9.46 554 | 47    | 0.53 446 | 9.98 222 | 4  | 3 13.5 13.2 12.9      |
| 18 | 9.44 819 | 43 | 9.46 601 | 47    | 0.53 399 | 9.98 218 | 3  | 4 18.0 17.6 17.2      |
| 19 | 9.44 862 | 43 | 9.46 648 | 46    | 0.53 352 | 9.98 215 | 4  | 5 22.5 22.0 21.5      |
| 20 | 9.44 905 | 43 | 9.46 694 | 47    | 0.53 306 | 9.98 211 | 5  | 6 27.0 26.4 25.8      |
| 21 | 9.44 948 | 44 | 9.46 741 | 47    | 0.53 259 | 9.98 207 | 6  | 7 31.5 30.8 30.1      |
| 22 | 9.44 992 | 44 | 9.46 788 | 47    | 0.53 212 | 9.98 204 | 7  | 8 36.0 35.2 34.4      |
| 23 | 9.45 035 | 43 | 9.46 835 | 47    | 0.53 165 | 9.98 200 | 8  | 9 40.5 39.6 38.7      |
| 24 | 9.45 077 | 43 | 9.46 881 | 47    | 0.53 119 | 9.98 196 | 4  |                       |
| 25 | 9.45 120 | 43 | 9.46 928 | 47    | 0.53 072 | 9.98 192 | 3  | 42 41                 |
| 26 | 9.45 163 | 43 | 9.46 975 | 47    | 0.53 025 | 9.98 189 | 4  | 1 4.2 4.1             |
| 27 | 9.45 206 | 43 | 9.47 021 | 46    | 0.52 979 | 9.98 185 | 5  | 2 8.4 8.2             |
| 28 | 9.45 249 | 43 | 9.47 068 | 46    | 0.52 932 | 9.98 181 | 4  | 3 12.6 12.3           |
| 29 | 9.45 292 | 42 | 9.47 114 | 46    | 0.52 886 | 9.98 177 | 3  | 4 16.8 16.4           |
| 30 | 9.45 334 | 43 | 9.47 160 | 47    | 0.52 840 | 9.98 174 | 4  | 5 21.0 20.5           |
| 31 | 9.45 377 | 42 | 9.47 207 | 47    | 0.52 793 | 9.98 170 | 5  | 6 25.2 24.6           |
| 32 | 9.45 419 | 43 | 9.47 253 | 46    | 0.52 747 | 9.98 166 | 6  | 7 29.4 28.7           |
| 33 | 9.45 462 | 42 | 9.47 299 | 47    | 0.52 701 | 9.98 162 | 7  | 8 33.6 32.8           |
| 34 | 9.45 504 | 43 | 9.47 346 | 46    | 0.52 654 | 9.98 159 | 8  | 9 37.8 36.9           |
| 35 | 9.45 547 | 42 | 9.47 392 | 46    | 0.52 608 | 9.98 155 | 4  |                       |
| 36 | 9.45 589 | 42 | 9.47 438 | 46    | 0.52 562 | 9.98 151 | 3  | 4 3                   |
| 37 | 9.45 632 | 43 | 9.47 484 | 46    | 0.52 516 | 9.98 147 | 4  | 1 0.4 0.3             |
| 38 | 9.45 674 | 42 | 9.47 530 | 46    | 0.52 470 | 9.98 144 | 5  | 2 0.8 0.6             |
| 39 | 9.45 716 | 42 | 9.47 576 | 46    | 0.52 424 | 9.98 140 | 6  | 3 1.2 0.9             |
| 40 | 9.45 758 | 43 | 9.47 622 | 46    | 0.52 378 | 9.98 136 | 7  | 4 1.6 1.2             |
| 41 | 9.45 801 | 42 | 9.47 668 | 46    | 0.52 332 | 9.98 132 | 8  | 5 2.0 1.5             |
| 42 | 9.45 843 | 42 | 9.47 714 | 46    | 0.52 286 | 9.98 129 | 9  | 6 2.4 1.8             |
| 43 | 9.45 885 | 42 | 9.47 760 | 46    | 0.52 240 | 9.98 125 | 4  | 7 2.8 2.1             |
| 44 | 9.45 927 | 42 | 9.47 806 | 46    | 0.52 194 | 9.98 121 | 5  | 8 3.2 2.4             |
| 45 | 9.45 969 | 42 | 9.47 852 | 45    | 0.52 148 | 9.98 117 | 6  | 9 3.6 2.7             |
| 46 | 9.46 011 | 42 | 9.47 897 | 46    | 0.52 103 | 9.98 113 | 4  |                       |
| 47 | 9.46 053 | 42 | 9.47 943 | 46    | 0.52 057 | 9.98 110 | 3  | 4 4                   |
| 48 | 9.46 095 | 41 | 9.47 989 | 46    | 0.52 011 | 9.98 106 | 4  | 48 47 46 45           |
| 49 | 9.46 136 | 42 | 9.48 035 | 45    | 0.51 965 | 9.98 102 | 5  | 1 6.0 5.9 5.8 5.6     |
| 50 | 9.46 178 | 42 | 9.48 080 | 46    | 0.51 920 | 9.98 098 | 6  | 2 18.0 17.6 17.2 16.9 |
| 51 | 9.46 220 | 42 | 9.48 126 | 45    | 0.51 874 | 9.98 094 | 7  | 3 30.0 29.4 28.8 28.1 |
| 52 | 9.46 262 | 41 | 9.48 171 | 45    | 0.51 829 | 9.98 090 | 8  | 4 42.0 41.1 40.2 39.4 |
| 53 | 9.46 303 | 42 | 9.48 217 | 45    | 0.51 783 | 9.98 087 | 4  |                       |
| 54 | 9.46 345 | 41 | 9.48 262 | 45    | 0.51 738 | 9.98 083 | 3  | 3 3                   |
| 55 | 9.46 386 | 42 | 9.48 307 | 45    | 0.51 693 | 9.98 079 | 4  | 48 47 46 45           |
| 56 | 9.46 428 | 41 | 9.48 353 | 46    | 0.51 647 | 9.98 075 | 5  |                       |
| 57 | 9.46 469 | 41 | 9.48 398 | 45    | 0.51 602 | 9.98 071 | 6  | 1 8.0 7.8 7.7 7.5     |
| 58 | 9.46 511 | 42 | 9.48 443 | 45    | 0.51 557 | 9.98 067 | 7  | 2 24.0 23.5 23.0 22.5 |
| 59 | 9.46 552 | 42 | 9.48 489 | 46    | 0.51 511 | 9.98 063 | 8  | 3 40.0 39.2 38.3 37.5 |
| 60 | 9.46 594 | 42 | 9.48 534 | 45    | 0.51 466 | 9.98 060 | 9  |                       |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. | P. P.                 |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P. |
|----|----------|----|----------|-------|----------|----------|----|----|-------|
| 0  | 9.46 594 | 41 | 9.48 534 | 45    | 0.51 466 | 9.98 060 | 4  | 60 |       |
| 1  | 9.46 635 | 41 | 9.48 579 | 45    | 0.51 421 | 9.98 056 | 4  | 59 |       |
| 2  | 9.46 676 | 41 | 9.48 624 | 45    | 0.51 376 | 9.98 052 | 4  | 58 |       |
| 3  | 9.46 717 | 41 | 9.48 669 | 45    | 0.51 331 | 9.98 048 | 4  | 57 |       |
| 4  | 9.46 758 | 42 | 9.48 714 | 45    | 0.51 286 | 9.98 044 | 4  | 56 |       |
| 5  | 9.46 800 | 41 | 9.48 759 | 45    | 0.51 241 | 9.98 040 | 4  | 55 |       |
| 6  | 9.46 841 | 41 | 9.48 804 | 45    | 0.51 196 | 9.98 036 | 4  | 54 |       |
| 7  | 9.46 882 | 41 | 9.48 849 | 45    | 0.51 151 | 9.98 032 | 4  | 53 |       |
| 8  | 9.46 923 | 41 | 9.48 894 | 45    | 0.51 106 | 9.98 029 | 3  | 52 |       |
| 9  | 9.46 964 | 41 | 9.48 939 | 45    | 0.51 061 | 9.98 025 | 4  | 51 |       |
| 10 | 9.47 005 | 40 | 9.48 984 | 45    | 0.51 016 | 9.98 021 | 4  | 50 |       |
| 11 | 9.47 045 | 41 | 9.49 029 | 44    | 0.50 971 | 9.98 017 | 4  | 49 |       |
| 12 | 9.47 086 | 41 | 9.49 073 | 45    | 0.50 927 | 9.98 013 | 4  | 48 |       |
| 13 | 9.47 127 | 41 | 9.49 118 | 45    | 0.50 882 | 9.98 009 | 4  | 47 |       |
| 14 | 9.47 168 | 41 | 9.49 163 | 44    | 0.50 837 | 9.98 005 | 4  | 46 |       |
| 15 | 9.47 209 | 40 | 9.49 207 | 45    | 0.50 793 | 9.98 001 | 4  | 45 |       |
| 16 | 9.47 249 | 40 | 9.49 252 | 45    | 0.50 748 | 9.97 997 | 4  | 44 |       |
| 17 | 9.47 290 | 40 | 9.49 296 | 44    | 0.50 704 | 9.97 993 | 4  | 43 |       |
| 18 | 9.47 330 | 41 | 9.49 341 | 45    | 0.50 659 | 9.97 989 | 4  | 42 |       |
| 19 | 9.47 371 | 40 | 9.49 385 | 45    | 0.50 615 | 9.97 986 | 3  | 41 |       |
| 20 | 9.47 411 | 41 | 9.49 430 | 44    | 0.50 570 | 9.97 982 | 4  | 40 |       |
| 21 | 9.47 452 | 41 | 9.49 474 | 45    | 0.50 526 | 9.97 978 | 4  | 39 |       |
| 22 | 9.47 492 | 41 | 9.49 519 | 44    | 0.50 481 | 9.97 974 | 4  | 38 |       |
| 23 | 9.47 533 | 40 | 9.49 563 | 44    | 0.50 437 | 9.97 970 | 4  | 37 |       |
| 24 | 9.47 573 | 40 | 9.49 607 | 45    | 0.50 393 | 9.97 966 | 4  | 36 |       |
| 25 | 9.47 613 | 41 | 9.49 652 | 44    | 0.50 348 | 9.97 962 | 4  | 35 |       |
| 26 | 9.47 654 | 41 | 9.49 696 | 44    | 0.50 304 | 9.97 958 | 4  | 34 |       |
| 27 | 9.47 694 | 40 | 9.49 740 | 44    | 0.50 260 | 9.97 954 | 4  | 33 |       |
| 28 | 9.47 734 | 40 | 9.49 784 | 44    | 0.50 216 | 9.97 950 | 4  | 32 |       |
| 29 | 9.47 774 | 40 | 9.49 828 | 44    | 0.50 172 | 9.97 946 | 4  | 31 |       |
| 30 | 9.47 814 | 40 | 9.49 872 | 44    | 0.50 128 | 9.97 942 | 4  | 30 |       |
| 31 | 9.47 854 | 40 | 9.49 916 | 44    | 0.50 084 | 9.97 938 | 4  | 29 |       |
| 32 | 9.47 894 | 40 | 9.49 960 | 44    | 0.50 040 | 9.97 934 | 4  | 28 |       |
| 33 | 9.47 934 | 40 | 9.50 004 | 44    | 0.49 996 | 9.97 930 | 4  | 27 |       |
| 34 | 9.47 974 | 40 | 9.50 048 | 44    | 0.49 952 | 9.97 926 | 4  | 26 |       |
| 35 | 9.48 014 | 40 | 9.50 092 | 44    | 0.49 908 | 9.97 922 | 4  | 25 |       |
| 36 | 9.48 054 | 40 | 9.50 136 | 44    | 0.49 864 | 9.97 918 | 4  | 24 |       |
| 37 | 9.48 094 | 39 | 9.50 180 | 43    | 0.49 820 | 9.97 914 | 4  | 23 |       |
| 38 | 9.48 133 | 39 | 9.50 223 | 44    | 0.49 777 | 9.97 910 | 4  | 22 |       |
| 39 | 9.48 173 | 40 | 9.50 267 | 44    | 0.49 733 | 9.97 906 | 4  | 21 |       |
| 40 | 9.48 213 | 39 | 9.50 311 | 44    | 0.49 689 | 9.97 902 | 4  | 20 |       |
| 41 | 9.48 252 | 39 | 9.50 355 | 44    | 0.49 645 | 9.97 898 | 4  | 19 |       |
| 42 | 9.48 292 | 40 | 9.50 398 | 43    | 0.49 602 | 9.97 894 | 4  | 18 |       |
| 43 | 9.48 332 | 39 | 9.50 442 | 43    | 0.49 558 | 9.97 890 | 4  | 17 |       |
| 44 | 9.48 371 | 40 | 9.50 485 | 44    | 0.49 515 | 9.97 886 | 4  | 16 |       |
| 45 | 9.48 411 | 39 | 9.50 529 | 43    | 0.49 471 | 9.97 882 | 4  | 15 |       |
| 46 | 9.48 450 | 39 | 9.50 572 | 43    | 0.49 428 | 9.97 878 | 4  | 14 |       |
| 47 | 9.48 490 | 39 | 9.50 616 | 44    | 0.49 384 | 9.97 874 | 4  | 13 |       |
| 48 | 9.48 529 | 39 | 9.50 659 | 43    | 0.49 341 | 9.97 870 | 4  | 12 |       |
| 49 | 9.48 568 | 39 | 9.50 703 | 43    | 0.49 297 | 9.97 866 | 4  | 11 |       |
| 50 | 9.48 607 | 40 | 9.50 746 | 43    | 0.49 254 | 9.97 861 | 5  | 10 |       |
| 51 | 9.48 647 | 39 | 9.50 789 | 44    | 0.49 211 | 9.97 857 | 4  | 9  |       |
| 52 | 9.48 686 | 39 | 9.50 833 | 43    | 0.49 167 | 9.97 853 | 4  | 8  |       |
| 53 | 9.48 725 | 39 | 9.50 876 | 43    | 0.49 124 | 9.97 849 | 4  | 7  |       |
| 54 | 9.48 764 | 39 | 9.50 919 | 43    | 0.49 081 | 9.97 845 | 4  | 6  |       |
| 55 | 9.48 803 | 39 | 9.50 962 | 43    | 0.49 038 | 9.97 841 | 4  | 5  |       |
| 56 | 9.48 842 | 39 | 9.51 005 | 43    | 0.48 995 | 9.97 837 | 4  | 4  |       |
| 57 | 9.48 881 | 39 | 9.51 048 | 43    | 0.48 952 | 9.97 833 | 4  | 3  |       |
| 58 | 9.48 920 | 39 | 9.51 092 | 44    | 0.48 908 | 9.97 829 | 4  | 2  |       |
| 59 | 9.48 959 | 39 | 9.51 135 | 43    | 0.48 865 | 9.97 825 | 4  | 1  |       |
| 60 | 9.48 998 | 39 | 9.51 178 | 43    | 0.48 822 | 9.97 821 | 4  | 0  |       |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P. |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.            |
|----|----------|----|----------|-------|----------|----------|----|----|------------------|
| 0  | 9.48 998 | 39 | 9.51 178 | 43    | 0.48 822 | 9.97 821 | 4  | 60 |                  |
| 1  | 9.49 037 | 39 | 9.51 221 | 43    | 0.48 779 | 9.97 817 | 5  | 59 |                  |
| 2  | 9.49 076 | 39 | 9.51 264 | 42    | 0.48 736 | 9.97 812 | 5  | 58 |                  |
| 3  | 9.49 115 | 39 | 9.51 306 | 42    | 0.48 694 | 9.97 808 | 4  | 57 | 43 42 41         |
| 4  | 9.49 153 | 38 | 9.51 349 | 43    | 0.48 651 | 9.97 804 | 4  | 56 | 1 4.3 4.2 4.1    |
| 5  | 9.49 192 | 39 | 9.51 392 | 43    | 0.48 608 | 9.97 800 | 4  | 55 | 2 8.6 8.4 8.2    |
| 6  | 9.49 231 | 38 | 9.51 435 | 43    | 0.48 565 | 9.97 796 | 4  | 54 | 3 12.9 12.6 12.3 |
| 7  | 9.49 269 | 39 | 9.51 478 | 42    | 0.48 522 | 9.97 792 | 4  | 53 | 4 17.2 16.8 16.4 |
| 8  | 9.49 308 | 39 | 9.51 520 | 42    | 0.48 480 | 9.97 788 | 4  | 52 | 5 21.5 21.0 20.5 |
| 9  | 9.49 347 | 38 | 9.51 563 | 43    | 0.48 437 | 9.97 784 | 4  | 51 | 6 25.8 25.2 24.6 |
| 10 | 9.49 385 | 39 | 9.51 606 | 42    | 0.48 394 | 9.97 779 | 5  | 50 | 7 30.1 29.4 28.7 |
| 11 | 9.49 424 | 38 | 9.51 648 | 43    | 0.48 352 | 9.97 775 | 4  | 49 | 8 34.4 33.6 32.8 |
| 12 | 9.49 462 | 38 | 9.51 691 | 43    | 0.48 309 | 9.97 771 | 4  | 48 | 9 38.7 37.8 36.9 |
| 13 | 9.49 500 | 38 | 9.51 734 | 43    | 0.48 266 | 9.97 767 | 4  | 47 |                  |
| 14 | 9.49 539 | 39 | 9.51 776 | 42    | 0.48 224 | 9.97 763 | 4  | 46 |                  |
| 15 | 9.49 577 | 38 | 9.51 819 | 42    | 0.48 181 | 9.97 759 | 4  | 45 | 39 38 37         |
| 16 | 9.49 615 | 39 | 9.51 861 | 42    | 0.48 139 | 9.97 754 | 5  | 44 | 1 3.9 3.8 3.7    |
| 17 | 9.49 654 | 38 | 9.51 903 | 43    | 0.48 097 | 9.97 750 | 4  | 43 | 2 7.8 7.6 7.4    |
| 18 | 9.49 692 | 38 | 9.51 946 | 43    | 0.48 054 | 9.97 746 | 4  | 42 | 3 11.7 11.4 11.1 |
| 19 | 9.49 730 | 38 | 9.51 988 | 43    | 0.48 012 | 9.97 742 | 4  | 41 | 4 15.6 15.2 14.8 |
| 20 | 9.49 768 | 38 | 9.52 031 | 42    | 0.47 969 | 9.97 738 | 4  | 40 | 5 19.5 19.0 18.5 |
| 21 | 9.49 806 | 38 | 9.52 073 | 42    | 0.47 927 | 9.97 734 | 4  | 39 | 6 23.4 22.8 22.2 |
| 22 | 9.49 844 | 38 | 9.52 115 | 42    | 0.47 885 | 9.97 729 | 5  | 38 | 7 27.3 26.6 25.9 |
| 23 | 9.49 882 | 38 | 9.52 157 | 42    | 0.47 843 | 9.97 725 | 4  | 37 | 8 31.2 30.4 29.6 |
| 24 | 9.49 920 | 38 | 9.52 200 | 43    | 0.47 800 | 9.97 721 | 4  | 36 | 9 35.1 34.2 33.3 |
| 25 | 9.49 958 | 38 | 9.52 242 | 42    | 0.47 758 | 9.97 717 | 4  | 35 |                  |
| 26 | 9.49 996 | 38 | 9.52 284 | 42    | 0.47 716 | 9.97 713 | 5  | 34 |                  |
| 27 | 9.50 034 | 38 | 9.52 326 | 42    | 0.47 674 | 9.97 708 | 4  | 33 | 36 5 4           |
| 28 | 9.50 072 | 38 | 9.52 368 | 42    | 0.47 632 | 9.97 704 | 4  | 32 | 1 3.6 0.5 0.4    |
| 29 | 9.50 110 | 38 | 9.52 410 | 42    | 0.47 590 | 9.97 700 | 4  | 31 | 2 7.2 1.0 0.8    |
| 30 | 9.50 148 | 37 | 9.52 452 | 42    | 0.47 548 | 9.97 696 | 4  | 30 | 3 10.8 1.5 1.2   |
| 31 | 9.50 185 | 37 | 9.52 494 | 42    | 0.47 506 | 9.97 691 | 5  | 29 | 4 14.4 2.0 1.6   |
| 32 | 9.50 223 | 38 | 9.52 536 | 42    | 0.47 464 | 9.97 687 | 4  | 28 | 5 18.0 2.5 2.0   |
| 33 | 9.50 261 | 37 | 9.52 578 | 42    | 0.47 422 | 9.97 683 | 4  | 27 | 6 21.6 3.0 2.4   |
| 34 | 9.50 298 | 38 | 9.52 620 | 41    | 0.47 380 | 9.97 679 | 5  | 26 | 7 25.2 3.5 2.8   |
| 35 | 9.50 336 | 38 | 9.52 661 | 41    | 0.47 339 | 9.97 674 | 5  | 25 | 8 28.8 4.0 3.2   |
| 36 | 9.50 374 | 37 | 9.52 703 | 42    | 0.47 297 | 9.97 670 | 4  | 24 | 9 32.4 4.5 3.6   |
| 37 | 9.50 411 | 38 | 9.52 745 | 42    | 0.47 255 | 9.97 666 | 4  | 23 |                  |
| 38 | 9.50 449 | 37 | 9.52 787 | 42    | 0.47 213 | 9.97 662 | 4  | 22 |                  |
| 39 | 9.50 486 | 37 | 9.52 829 | 41    | 0.47 171 | 9.97 657 | 5  | 21 |                  |
| 40 | 9.50 523 | 38 | 9.52 870 | 42    | 0.47 130 | 9.97 653 | 4  | 20 |                  |
| 41 | 9.50 561 | 37 | 9.52 912 | 41    | 0.47 088 | 9.97 649 | 4  | 19 | 5 5 5            |
| 42 | 9.50 598 | 37 | 9.52 953 | 42    | 0.47 047 | 9.97 645 | 5  | 18 | 43 42 41         |
| 43 | 9.50 635 | 38 | 9.52 995 | 42    | 0.47 005 | 9.97 640 | 4  | 17 | 1 4.3 4.2 4.1    |
| 44 | 9.50 673 | 37 | 9.53 037 | 41    | 0.46 963 | 9.97 636 | 4  | 16 | 2 12.9 12.6 12.3 |
| 45 | 9.50 710 | 37 | 9.53 078 | 41    | 0.46 922 | 9.97 632 | 4  | 15 | 3 21.5 21.0 20.5 |
| 46 | 9.50 747 | 37 | 9.53 120 | 42    | 0.46 880 | 9.97 628 | 5  | 14 | 4 30.1 29.4 28.7 |
| 47 | 9.50 784 | 37 | 9.53 161 | 41    | 0.46 839 | 9.97 623 | 4  | 13 | 5 38.7 37.8 36.9 |
| 48 | 9.50 821 | 37 | 9.53 202 | 42    | 0.46 798 | 9.97 619 | 4  | 12 |                  |
| 49 | 9.50 858 | 38 | 9.53 244 | 41    | 0.46 756 | 9.97 615 | 5  | 11 |                  |
| 50 | 9.50 896 | 37 | 9.53 285 | 42    | 0.46 715 | 9.97 610 | 4  | 10 |                  |
| 51 | 9.50 933 | 37 | 9.53 327 | 41    | 0.46 673 | 9.97 606 | 4  | 9  | 4 4 4            |
| 52 | 9.50 970 | 37 | 9.53 368 | 41    | 0.46 632 | 9.97 602 | 5  | 8  | 43 42 41         |
| 53 | 9.51 007 | 36 | 9.53 409 | 41    | 0.46 591 | 9.97 597 | 4  | 7  | 1 5.4 5.2 5.1    |
| 54 | 9.51 043 | 37 | 9.53 450 | 42    | 0.46 550 | 9.97 593 | 4  | 6  | 2 16.1 15.8 15.4 |
| 55 | 9.51 080 | 37 | 9.53 492 | 41    | 0.46 508 | 9.97 589 | 5  | 5  | 3 26.9 26.2 25.6 |
| 56 | 9.51 117 | 37 | 9.53 533 | 41    | 0.46 467 | 9.97 584 | 4  | 4  | 4 37.6 36.8 35.9 |
| 57 | 9.51 154 | 37 | 9.53 574 | 41    | 0.46 426 | 9.97 580 | 4  | 3  |                  |
| 58 | 9.51 191 | 36 | 9.53 615 | 41    | 0.46 385 | 9.97 576 | 5  | 2  |                  |
| 59 | 9.51 227 | 37 | 9.53 656 | 41    | 0.46 344 | 9.97 571 | 4  | 1  |                  |
| 60 | 9.51 264 | 37 | 9.53 697 | 41    | 0.46 303 | 9.97 567 | 4  | 0  |                  |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P.            |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.          |
|----|----------|----|----------|-------|----------|----------|----|----|----------------|
| 0  | 9.51 264 | 37 | 9.53 697 | 41    | 0.46 303 | 9.97 567 | 4  | 60 |                |
| 1  | 9.51 301 | 37 | 9.53 738 | 41    | 0.46 262 | 9.97 563 | 5  | 59 |                |
| 2  | 9.51 338 | 36 | 9.53 779 | 41    | 0.46 221 | 9.97 558 | 5  | 58 |                |
| 3  | 9.51 374 | 37 | 9.53 820 | 41    | 0.46 180 | 9.97 554 | 4  | 57 | 41 40 39       |
| 4  | 9.51 411 | 36 | 9.53 861 | 41    | 0.46 139 | 9.97 550 | 5  | 56 | 4.1 4.0 3.9    |
| 5  | 9.51 447 | 37 | 9.53 902 | 41    | 0.46 098 | 9.97 545 | 5  | 55 | 8.2 8.0 7.8    |
| 6  | 9.51 484 | 36 | 9.53 943 | 41    | 0.46 057 | 9.97 541 | 4  | 54 | 12.3 12.0 11.7 |
| 7  | 9.51 520 | 37 | 9.53 984 | 41    | 0.46 016 | 9.97 536 | 5  | 53 | 16.4 16.0 15.6 |
| 8  | 9.51 557 | 36 | 9.54 025 | 41    | 0.45 975 | 9.97 532 | 4  | 52 | 20.5 20.0 19.5 |
| 9  | 9.51 593 | 36 | 9.54 065 | 41    | 0.45 935 | 9.97 528 | 4  | 51 | 24.6 24.0 23.4 |
| 10 | 9.51 629 | 37 | 9.54 106 | 41    | 0.45 894 | 9.97 523 | 5  | 50 | 28.7 28.0 27.3 |
| 11 | 9.51 666 | 36 | 9.54 147 | 41    | 0.45 853 | 9.97 519 | 4  | 49 | 32.8 32.0 31.2 |
| 12 | 9.51 702 | 36 | 9.54 187 | 41    | 0.45 813 | 9.97 515 | 4  | 48 | 36.9 36.0 35.1 |
| 13 | 9.51 738 | 36 | 9.54 228 | 41    | 0.45 772 | 9.97 510 | 5  | 47 |                |
| 14 | 9.51 774 | 37 | 9.54 269 | 40    | 0.45 731 | 9.97 506 | 4  | 46 |                |
| 15 | 9.51 811 | 36 | 9.54 309 | 40    | 0.45 691 | 9.97 501 | 5  | 45 | 37 36 35       |
| 16 | 9.51 847 | 36 | 9.54 350 | 41    | 0.45 650 | 9.97 497 | 4  | 44 |                |
| 17 | 9.51 883 | 36 | 9.54 390 | 40    | 0.45 610 | 9.97 492 | 5  | 43 | 3.7 3.6 3.5    |
| 18 | 9.51 919 | 36 | 9.54 431 | 41    | 0.45 569 | 9.97 488 | 4  | 42 | 7.4 7.2 7.0    |
| 19 | 9.51 955 | 36 | 9.54 471 | 41    | 0.45 529 | 9.97 484 | 4  | 41 | 11.1 10.8 10.5 |
| 20 | 9.51 991 | 36 | 9.54 512 | 41    | 0.45 488 | 9.97 479 | 5  | 40 | 14.8 14.4 14.0 |
| 21 | 9.52 027 | 36 | 9.54 552 | 41    | 0.45 448 | 9.97 475 | 4  | 39 | 18.5 18.0 17.5 |
| 22 | 9.52 063 | 36 | 9.54 593 | 40    | 0.45 407 | 9.97 470 | 5  | 38 | 22.2 21.6 21.0 |
| 23 | 9.52 099 | 36 | 9.54 633 | 40    | 0.45 367 | 9.97 466 | 4  | 37 | 25.9 25.2 24.5 |
| 24 | 9.52 135 | 36 | 9.54 673 | 41    | 0.45 327 | 9.97 461 | 5  | 36 | 29.6 28.8 28.0 |
| 25 | 9.52 171 | 36 | 9.54 714 | 40    | 0.45 286 | 9.97 457 | 4  | 35 | 33.3 32.4 31.5 |
| 26 | 9.52 207 | 35 | 9.54 754 | 40    | 0.45 246 | 9.97 453 | 4  | 34 |                |
| 27 | 9.52 242 | 36 | 9.54 794 | 41    | 0.45 206 | 9.97 448 | 5  | 33 | 34 5 4         |
| 28 | 9.52 278 | 36 | 9.54 835 | 41    | 0.45 165 | 9.97 444 | 4  | 32 |                |
| 29 | 9.52 314 | 36 | 9.54 875 | 40    | 0.45 125 | 9.97 439 | 5  | 31 | 3.4 0.5 0.4    |
| 30 | 9.52 350 | 36 | 9.54 915 | 40    | 0.45 085 | 9.97 435 | 4  | 30 | 6.8 1.0 0.8    |
| 31 | 9.52 385 | 35 | 9.54 955 | 40    | 0.45 045 | 9.97 430 | 5  | 29 | 10.2 1.5 1.2   |
| 32 | 9.52 421 | 35 | 9.54 995 | 40    | 0.45 005 | 9.97 426 | 4  | 28 | 13.6 2.0 1.6   |
| 33 | 9.52 456 | 35 | 9.55 035 | 40    | 0.44 965 | 9.97 421 | 5  | 27 | 17.0 2.5 2.0   |
| 34 | 9.52 492 | 35 | 9.55 075 | 40    | 0.44 925 | 9.97 417 | 4  | 26 | 20.4 3.0 2.4   |
| 35 | 9.52 527 | 35 | 9.55 115 | 40    | 0.44 885 | 9.97 412 | 5  | 25 | 23.8 3.5 2.8   |
| 36 | 9.52 563 | 35 | 9.55 155 | 40    | 0.44 845 | 9.97 408 | 4  | 24 | 27.2 4.0 3.2   |
| 37 | 9.52 598 | 35 | 9.55 195 | 40    | 0.44 805 | 9.97 403 | 5  | 23 | 30.6 4.5 3.6   |
| 38 | 9.52 634 | 36 | 9.55 235 | 40    | 0.44 765 | 9.97 399 | 4  | 22 |                |
| 39 | 9.52 669 | 36 | 9.55 275 | 40    | 0.44 725 | 9.97 394 | 5  | 21 |                |
| 40 | 9.52 705 | 36 | 9.55 315 | 40    | 0.44 685 | 9.97 390 | 4  | 20 |                |
| 41 | 9.52 740 | 35 | 9.55 355 | 40    | 0.44 645 | 9.97 385 | 5  | 19 | 5 5 5          |
| 42 | 9.52 775 | 35 | 9.55 395 | 40    | 0.44 605 | 9.97 381 | 4  | 18 | 41 40 39       |
| 43 | 9.52 811 | 35 | 9.55 434 | 39    | 0.44 566 | 9.97 376 | 5  | 17 |                |
| 44 | 9.52 846 | 35 | 9.55 474 | 40    | 0.44 526 | 9.97 372 | 4  | 16 | 4.1 4.0 3.9    |
| 45 | 9.52 881 | 35 | 9.55 514 | 40    | 0.44 486 | 9.97 367 | 5  | 15 | 12.3 12.0 11.7 |
| 46 | 9.52 916 | 35 | 9.55 554 | 39    | 0.44 446 | 9.97 363 | 4  | 14 | 20.5 20.0 19.5 |
| 47 | 9.52 951 | 35 | 9.55 593 | 40    | 0.44 407 | 9.97 358 | 5  | 13 | 28.7 28.0 27.3 |
| 48 | 9.52 986 | 35 | 9.55 633 | 40    | 0.44 367 | 9.97 353 | 4  | 12 | 36.9 36.0 35.1 |
| 49 | 9.53 021 | 35 | 9.55 673 | 39    | 0.44 327 | 9.97 349 | 5  | 11 |                |
| 50 | 9.53 056 | 36 | 9.55 712 | 40    | 0.44 288 | 9.97 344 | 4  | 10 |                |
| 51 | 9.53 092 | 34 | 9.55 752 | 39    | 0.44 248 | 9.97 340 | 5  | 9  | 5.1 5.0 4.9    |
| 52 | 9.53 126 | 35 | 9.55 791 | 40    | 0.44 209 | 9.97 335 | 4  | 8  | 15.4 15.0 14.6 |
| 53 | 9.53 161 | 35 | 9.55 831 | 39    | 0.44 169 | 9.97 331 | 5  | 7  | 25.6 25.0 24.4 |
| 54 | 9.53 196 | 35 | 9.55 870 | 40    | 0.44 130 | 9.97 326 | 4  | 6  | 35.9 35.0 34.1 |
| 55 | 9.53 231 | 35 | 9.55 910 | 39    | 0.44 090 | 9.97 322 | 5  | 5  |                |
| 56 | 9.53 266 | 35 | 9.55 949 | 40    | 0.44 051 | 9.97 317 | 4  | 4  |                |
| 57 | 9.53 301 | 35 | 9.55 989 | 39    | 0.44 011 | 9.97 312 | 5  | 3  |                |
| 58 | 9.53 336 | 34 | 9.56 028 | 39    | 0.43 972 | 9.97 308 | 4  | 2  |                |
| 59 | 9.53 370 | 35 | 9.56 067 | 40    | 0.43 933 | 9.97 303 | 5  | 1  |                |
| 60 | 9.53 405 |    | 9.56 107 |       | 0.43 893 | 9.97 299 | 4  | 0  |                |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P.          |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.            |
|----|----------|----|----------|-------|----------|----------|----|----|------------------|
| 0  | 9.53 405 |    | 9.56 107 |       | 0.43 893 | 9.97 299 |    | 60 |                  |
| 1  | 9.53 440 | 35 | 9.56 146 | 39    | 0.43 854 | 9.97 294 | 5  | 59 |                  |
| 2  | 9.53 475 | 35 | 9.56 185 | 39    | 0.43 815 | 9.97 289 | 5  | 58 |                  |
| 3  | 9.53 509 | 34 | 9.56 224 | 40    | 0.43 776 | 9.97 285 | 5  | 57 | 40 39 38         |
| 4  | 9.53 544 | 35 | 9.56 264 | 39    | 0.43 736 | 9.97 280 | 5  | 56 | I 4.0 3.9 3.8    |
| 5  | 9.53 578 | 34 | 9.56 303 | 39    | 0.43 697 | 9.97 276 | 5  | 55 | 2 8.0 7.8 7.6    |
| 6  | 9.53 613 | 35 | 9.56 342 | 39    | 0.43 658 | 9.97 271 | 5  | 54 | 3 12.0 11.7 11.4 |
| 7  | 9.53 647 | 34 | 9.56 381 | 39    | 0.43 619 | 9.97 266 | 5  | 53 | 4 16.0 15.6 15.2 |
| 8  | 9.53 682 | 35 | 9.56 420 | 39    | 0.43 580 | 9.97 262 | 5  | 52 | 5 20.0 19.5 19.0 |
| 9  | 9.53 716 | 34 | 9.56 459 | 39    | 0.43 541 | 9.97 257 | 5  | 51 | 6 24.0 23.4 22.8 |
| 10 | 9.53 751 | 35 | 9.56 498 | 39    | 0.43 502 | 9.97 252 | 5  | 50 | 7 28.0 27.3 26.6 |
| 11 | 9.53 785 | 34 | 9.56 537 | 39    | 0.43 463 | 9.97 248 | 4  | 49 | 8 32.0 31.2 30.4 |
| 12 | 9.53 819 | 34 | 9.56 576 | 39    | 0.43 424 | 9.97 243 | 5  | 48 | 9 36.0 35.1 34.2 |
| 13 | 9.53 854 | 35 | 9.56 615 | 39    | 0.43 385 | 9.97 238 | 5  | 47 |                  |
| 14 | 9.53 888 | 34 | 9.56 654 | 39    | 0.43 346 | 9.97 234 | 4  | 46 | 37 35 34         |
| 15 | 9.53 922 | 35 | 9.56 693 | 39    | 0.43 307 | 9.97 229 | 5  | 45 | I 3.7 3.5 3.4    |
| 16 | 9.53 957 | 35 | 9.56 732 | 39    | 0.43 268 | 9.97 224 | 5  | 44 | 2 7.4 7.0 6.8    |
| 17 | 9.53 991 | 34 | 9.56 771 | 39    | 0.43 229 | 9.97 220 | 4  | 43 | 3 11.1 10.5 10.2 |
| 18 | 9.54 025 | 34 | 9.56 810 | 39    | 0.43 190 | 9.97 215 | 5  | 42 | 4 14.8 14.0 13.6 |
| 19 | 9.54 059 | 34 | 9.56 849 | 38    | 0.43 151 | 9.97 210 | 4  | 41 | 5 18.5 17.5 17.0 |
| 20 | 9.54 093 | 34 | 9.56 887 | 39    | 0.43 113 | 9.97 206 | 5  | 40 | 6 22.2 21.0 20.4 |
| 21 | 9.54 127 | 34 | 9.56 926 | 39    | 0.43 074 | 9.97 201 | 5  | 39 | 7 25.9 24.5 23.8 |
| 22 | 9.54 161 | 34 | 9.56 965 | 39    | 0.43 035 | 9.97 196 | 5  | 38 | 8 29.6 28.0 27.2 |
| 23 | 9.54 195 | 34 | 9.57 004 | 38    | 0.42 996 | 9.97 192 | 4  | 37 | 9 33.3 31.5 30.6 |
| 24 | 9.54 229 | 34 | 9.57 042 | 39    | 0.42 958 | 9.97 187 | 5  | 36 |                  |
| 25 | 9.54 263 | 34 | 9.57 081 | 39    | 0.42 919 | 9.97 182 | 5  | 35 |                  |
| 26 | 9.54 297 | 34 | 9.57 120 | 39    | 0.42 880 | 9.97 178 | 4  | 34 | 33 5 4           |
| 27 | 9.54 331 | 34 | 9.57 158 | 38    | 0.42 842 | 9.97 173 | 5  | 33 | I 3.3 0.5 0.4    |
| 28 | 9.54 365 | 34 | 9.57 197 | 39    | 0.42 803 | 9.97 168 | 5  | 32 | 2 6.6 1.0 0.8    |
| 29 | 9.54 399 | 34 | 9.57 235 | 38    | 0.42 765 | 9.97 163 | 5  | 31 | 3 9.9 1.5 1.2    |
| 30 | 9.54 433 | 34 | 9.57 274 | 39    | 0.42 726 | 9.97 159 | 4  | 30 | 4 13.2 2.0 1.6   |
| 31 | 9.54 466 | 33 | 9.57 312 | 38    | 0.42 688 | 9.97 154 | 5  | 29 | 5 16.5 2.5 2.0   |
| 32 | 9.54 500 | 34 | 9.57 351 | 39    | 0.42 649 | 9.97 149 | 5  | 28 | 6 19.8 3.0 2.4   |
| 33 | 9.54 534 | 34 | 9.57 389 | 38    | 0.42 611 | 9.97 145 | 4  | 27 | 7 23.1 3.5 2.8   |
| 34 | 9.54 567 | 33 | 9.57 428 | 39    | 0.42 572 | 9.97 140 | 5  | 26 | 8 26.4 4.0 3.2   |
| 35 | 9.54 601 | 34 | 9.57 466 | 38    | 0.42 534 | 9.97 135 | 5  | 25 | 9 29.7 4.5 3.6   |
| 36 | 9.54 635 | 34 | 9.57 504 | 38    | 0.42 496 | 9.97 130 | 5  | 24 |                  |
| 37 | 9.54 668 | 33 | 9.57 543 | 39    | 0.42 457 | 9.97 126 | 4  | 23 |                  |
| 38 | 9.54 702 | 34 | 9.57 581 | 38    | 0.42 419 | 9.97 121 | 5  | 22 |                  |
| 39 | 9.54 735 | 33 | 9.57 619 | 38    | 0.42 381 | 9.97 116 | 5  | 21 |                  |
| 40 | 9.54 769 | 33 | 9.57 658 | 38    | 0.42 342 | 9.97 111 | 5  | 20 |                  |
| 41 | 9.54 802 | 34 | 9.57 696 | 38    | 0.42 304 | 9.97 107 | 4  | 19 | 5 5 5            |
| 42 | 9.54 836 | 34 | 9.57 734 | 38    | 0.42 266 | 9.97 102 | 5  | 18 | 40 39 38         |
| 43 | 9.54 869 | 33 | 9.57 772 | 38    | 0.42 228 | 9.97 097 | 5  | 17 |                  |
| 44 | 9.54 903 | 34 | 9.57 810 | 39    | 0.42 190 | 9.97 092 | 5  | 16 | I 4.0 3.9 3.8    |
| 45 | 9.54 936 | 33 | 9.57 849 | 38    | 0.42 151 | 9.97 087 | 5  | 15 | 2 12.0 11.7 11.4 |
| 46 | 9.54 969 | 33 | 9.57 887 | 38    | 0.42 113 | 9.97 083 | 4  | 14 | 3 20.0 19.5 19.0 |
| 47 | 9.55 003 | 34 | 9.57 925 | 38    | 0.42 075 | 9.97 078 | 5  | 13 | 4 28.0 27.3 26.6 |
| 48 | 9.55 036 | 33 | 9.57 963 | 38    | 0.42 037 | 9.97 073 | 5  | 12 | 5 36.0 35.1 34.2 |
| 49 | 9.55 069 | 33 | 9.58 001 | 38    | 0.41 999 | 9.97 068 | 5  | 11 |                  |
| 50 | 9.55 102 | 33 | 9.58 039 | 38    | 0.41 961 | 9.97 063 | 5  | 10 |                  |
| 51 | 9.55 136 | 34 | 9.58 077 | 38    | 0.41 923 | 9.97 059 | 4  | 9  | 5 4 4            |
| 52 | 9.55 169 | 33 | 9.58 115 | 38    | 0.41 885 | 9.97 054 | 5  | 8  | 37 39 38         |
| 53 | 9.55 202 | 33 | 9.58 153 | 38    | 0.41 847 | 9.97 049 | 5  | 7  |                  |
| 54 | 9.55 235 | 33 | 9.58 191 | 38    | 0.41 809 | 9.97 044 | 5  | 6  | I 3.7 4.9 4.8    |
| 55 | 9.55 268 | 33 | 9.58 229 | 38    | 0.41 771 | 9.97 039 | 5  | 5  | 2 11.1 14.6 14.2 |
| 56 | 9.55 301 | 33 | 9.58 267 | 38    | 0.41 733 | 9.97 035 | 4  | 4  | 3 18.5 24.4 23.8 |
| 57 | 9.55 334 | 33 | 9.58 304 | 37    | 0.41 696 | 9.97 030 | 5  | 3  | 4 25.9 34.1 33.2 |
| 58 | 9.55 367 | 33 | 9.58 342 | 38    | 0.41 658 | 9.97 025 | 5  | 2  | 5 33.3 — —       |
| 59 | 9.55 400 | 33 | 9.58 380 | 38    | 0.41 620 | 9.97 020 | 5  | 1  |                  |
| 60 | 9.55 433 | 33 | 9.58 418 | 38    | 0.41 582 | 9.97 015 | 5  | 0  |                  |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P.            |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.            |
|----|----------|----|----------|-------|----------|----------|----|----|------------------|
| 0  | 9.55 433 | 33 | 9.58 418 | 37    | 0.41 582 | 9.97 015 | 5  | 60 |                  |
| 1  | 9.55 466 | 33 | 9.58 455 | 38    | 0.41 545 | 9.97 010 | 5  | 59 |                  |
| 2  | 9.55 499 | 33 | 9.58 493 | 38    | 0.41 507 | 9.97 005 | 5  | 58 |                  |
| 3  | 9.55 532 | 32 | 9.58 531 | 38    | 0.41 469 | 9.97 001 | 5  | 57 | 38 37 36         |
| 4  | 9.55 564 | 33 | 9.58 569 | 37    | 0.41 431 | 9.96 996 | 5  | 56 | 1 3.8 3.7 3.6    |
| 5  | 9.55 597 | 33 | 9.58 606 | 38    | 0.41 394 | 9.96 991 | 5  | 55 | 2 7.6 7.4 7.2    |
| 6  | 9.55 630 | 33 | 9.58 644 | 38    | 0.41 356 | 9.96 986 | 5  | 54 | 3 11.4 11.1 10.8 |
| 7  | 9.55 663 | 32 | 9.58 681 | 37    | 0.41 319 | 9.96 981 | 5  | 53 | 4 15.2 14.8 14.4 |
| 8  | 9.55 695 | 33 | 9.58 719 | 38    | 0.41 281 | 9.96 976 | 5  | 52 | 5 19.0 18.5 18.0 |
| 9  | 9.55 728 | 33 | 9.58 757 | 38    | 0.41 243 | 9.96 971 | 5  | 51 | 6 22.8 22.2 21.6 |
| 10 | 9.55 761 | 32 | 9.58 794 | 37    | 0.41 205 | 9.96 966 | 5  | 50 | 7 26.6 25.9 25.2 |
| 11 | 9.55 793 | 33 | 9.58 832 | 38    | 0.41 168 | 9.96 962 | 4  | 49 | 8 30.4 29.6 28.8 |
| 12 | 9.55 826 | 32 | 9.58 869 | 38    | 0.41 131 | 9.96 957 | 5  | 48 | 9 34.2 33.3 32.4 |
| 13 | 9.55 858 | 32 | 9.58 907 | 37    | 0.41 093 | 9.96 952 | 5  | 47 |                  |
| 14 | 9.55 891 | 32 | 9.58 944 | 37    | 0.41 056 | 9.96 947 | 5  | 46 | 38 32 31         |
| 15 | 9.55 923 | 32 | 9.58 981 | 37    | 0.41 019 | 9.96 942 | 5  | 45 | 1 3.3 3.2 3.1    |
| 16 | 9.55 956 | 33 | 9.59 019 | 38    | 0.40 981 | 9.96 937 | 5  | 44 | 2 6.6 6.4 6.2    |
| 17 | 9.55 988 | 32 | 9.59 056 | 38    | 0.40 944 | 9.96 932 | 5  | 43 | 3 9.9 9.6 9.3    |
| 18 | 9.56 021 | 32 | 9.59 094 | 38    | 0.40 906 | 9.96 927 | 5  | 42 | 4 13.2 12.8 12.4 |
| 19 | 9.56 053 | 32 | 9.59 131 | 37    | 0.40 869 | 9.96 922 | 5  | 41 | 5 16.5 16.0 15.5 |
| 20 | 9.56 085 | 33 | 9.59 168 | 37    | 0.40 832 | 9.96 917 | 5  | 40 | 6 19.8 19.2 18.6 |
| 21 | 9.56 118 | 32 | 9.59 205 | 38    | 0.40 795 | 9.96 912 | 5  | 39 | 7 23.1 22.4 21.7 |
| 22 | 9.56 150 | 32 | 9.59 243 | 37    | 0.40 757 | 9.96 907 | 5  | 38 | 8 26.4 25.6 24.8 |
| 23 | 9.56 182 | 32 | 9.59 280 | 37    | 0.40 720 | 9.96 903 | 4  | 37 | 9 29.7 28.8 27.9 |
| 24 | 9.56 215 | 33 | 9.59 317 | 37    | 0.40 683 | 9.96 898 | 5  | 36 |                  |
| 25 | 9.56 247 | 32 | 9.59 354 | 37    | 0.40 646 | 9.96 893 | 5  | 35 |                  |
| 26 | 9.56 279 | 32 | 9.59 391 | 38    | 0.40 609 | 9.96 888 | 5  | 34 | 6 5 4            |
| 27 | 9.56 311 | 32 | 9.59 429 | 37    | 0.40 571 | 9.96 883 | 5  | 33 | 1 0.6 0.5 0.4    |
| 28 | 9.56 343 | 32 | 9.59 466 | 37    | 0.40 534 | 9.96 878 | 5  | 32 | 2 1.2 1.0 0.8    |
| 29 | 9.56 375 | 33 | 9.59 503 | 37    | 0.40 497 | 9.96 873 | 5  | 31 | 3 1.8 1.5 1.2    |
| 30 | 9.56 408 | 32 | 9.59 540 | 37    | 0.40 460 | 9.96 868 | 5  | 30 | 4 2.4 2.0 1.6    |
| 31 | 9.56 440 | 32 | 9.59 577 | 37    | 0.40 423 | 9.96 863 | 5  | 29 | 5 3.0 2.5 2.0    |
| 32 | 9.56 472 | 32 | 9.59 614 | 37    | 0.40 386 | 9.96 858 | 5  | 28 | 6 3.6 3.0 2.4    |
| 33 | 9.56 504 | 32 | 9.59 651 | 37    | 0.40 349 | 9.96 853 | 5  | 27 | 7 4.2 3.5 2.8    |
| 34 | 9.56 536 | 32 | 9.59 688 | 37    | 0.40 312 | 9.96 848 | 5  | 26 | 8 4.8 4.0 3.2    |
| 35 | 9.56 568 | 31 | 9.59 725 | 37    | 0.40 275 | 9.96 843 | 5  | 25 | 9 5.4 4.5 3.6    |
| 36 | 9.56 599 | 32 | 9.59 762 | 37    | 0.40 238 | 9.96 838 | 5  | 24 |                  |
| 37 | 9.56 631 | 32 | 9.59 799 | 36    | 0.40 201 | 9.96 833 | 5  | 23 |                  |
| 38 | 9.56 663 | 32 | 9.59 835 | 37    | 0.40 165 | 9.96 828 | 5  | 22 |                  |
| 39 | 9.56 695 | 32 | 9.59 872 | 37    | 0.40 128 | 9.96 823 | 5  | 21 |                  |
| 40 | 9.56 727 | 32 | 9.59 909 | 37    | 0.40 091 | 9.96 818 | 5  | 20 | 6 5 5            |
| 41 | 9.56 759 | 31 | 9.59 946 | 37    | 0.40 054 | 9.96 813 | 5  | 19 | 87 88 87         |
| 42 | 9.56 790 | 32 | 9.59 983 | 36    | 0.40 017 | 9.96 808 | 5  | 18 |                  |
| 43 | 9.56 822 | 32 | 9.60 019 | 37    | 0.39 981 | 9.96 803 | 5  | 17 | 1 3.1 3.8 3.7    |
| 44 | 9.56 854 | 32 | 9.60 056 | 37    | 0.39 944 | 9.96 798 | 5  | 16 | 2 9.2 11.4 11.1  |
| 45 | 9.56 886 | 32 | 9.60 093 | 37    | 0.39 907 | 9.96 793 | 5  | 15 | 3 15.4 19.0 18.5 |
| 46 | 9.56 917 | 31 | 9.60 130 | 36    | 0.39 870 | 9.96 788 | 5  | 14 | 4 21.6 26.6 25.9 |
| 47 | 9.56 949 | 31 | 9.60 166 | 37    | 0.39 834 | 9.96 783 | 5  | 13 | 5 27.8 34.2 33.3 |
| 48 | 9.56 980 | 32 | 9.60 203 | 37    | 0.39 797 | 9.96 778 | 6  | 12 | 6 33.9 — —       |
| 49 | 9.57 012 | 32 | 9.60 240 | 36    | 0.39 760 | 9.96 772 | 5  | 11 |                  |
| 50 | 9.57 044 | 31 | 9.60 276 | 37    | 0.39 724 | 9.96 767 | 5  | 10 | 5 4 4            |
| 51 | 9.57 075 | 32 | 9.60 313 | 36    | 0.39 687 | 9.96 762 | 5  | 9  | 86 88 87         |
| 52 | 9.57 107 | 31 | 9.60 349 | 37    | 0.39 651 | 9.96 757 | 5  | 8  |                  |
| 53 | 9.57 138 | 31 | 9.60 386 | 36    | 0.39 614 | 9.96 752 | 5  | 7  | 1 3.6 4.8 4.6    |
| 54 | 9.57 169 | 32 | 9.60 422 | 37    | 0.39 578 | 9.96 747 | 5  | 6  | 2 10.8 14.2 13.9 |
| 55 | 9.57 201 | 31 | 9.60 459 | 36    | 0.39 541 | 9.96 742 | 5  | 5  | 3 18.0 23.8 23.1 |
| 56 | 9.57 232 | 32 | 9.60 495 | 36    | 0.39 505 | 9.96 737 | 5  | 4  | 4 25.2 33.2 32.4 |
| 57 | 9.57 264 | 31 | 9.60 532 | 37    | 0.39 468 | 9.96 732 | 5  | 3  | 5 32.4 — —       |
| 58 | 9.57 295 | 31 | 9.60 568 | 36    | 0.39 432 | 9.96 727 | 5  | 2  |                  |
| 59 | 9.57 326 | 32 | 9.60 605 | 36    | 0.39 395 | 9.96 722 | 5  | 1  |                  |
| 60 | 9.57 358 | 32 | 9.60 641 | 36    | 0.39 359 | 9.96 717 | 5  | 0  |                  |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P.            |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.            |
|----|----------|----|----------|-------|----------|----------|----|----|------------------|
| 0  | 9.57 358 | 31 | 9.60 641 | 36    | 0.39 359 | 9.96 717 | 6  | 60 |                  |
| 1  | 9.57 389 | 31 | 9.60 677 | 37    | 0.39 323 | 9.96 711 | 5  | 59 |                  |
| 2  | 9.57 420 | 31 | 9.60 714 | 37    | 0.39 286 | 9.96 706 | 5  | 58 | 37 36 35         |
| 3  | 9.57 451 | 31 | 9.60 750 | 36    | 0.39 250 | 9.96 701 | 5  | 57 | 1 3.7 3.6 3.5    |
| 4  | 9.57 482 | 32 | 9.60 786 | 37    | 0.39 214 | 9.96 696 | 5  | 56 | 2 7.4 7.2 7.0    |
| 5  | 9.57 514 | 31 | 9.60 823 | 36    | 0.39 177 | 9.96 691 | 5  | 55 | 3 11.1 10.8 10.5 |
| 6  | 9.57 545 | 31 | 9.60 859 | 36    | 0.39 141 | 9.96 686 | 5  | 54 | 4 14.8 14.4 14.0 |
| 7  | 9.57 576 | 31 | 9.60 895 | 36    | 0.39 105 | 9.96 681 | 5  | 53 | 5 18.5 18.0 17.5 |
| 8  | 9.57 607 | 31 | 9.60 931 | 36    | 0.39 069 | 9.96 676 | 5  | 52 | 6 22.2 21.6 21.0 |
| 9  | 9.57 638 | 31 | 9.60 967 | 37    | 0.39 033 | 9.96 670 | 5  | 51 | 7 25.9 25.2 24.5 |
| 10 | 9.57 669 | 31 | 9.61 004 | 36    | 0.38 996 | 9.96 665 | 5  | 50 | 8 29.6 28.8 28.0 |
| 11 | 9.57 700 | 31 | 9.61 040 | 36    | 0.38 960 | 9.96 660 | 5  | 49 | 9 33.3 32.4 31.5 |
| 12 | 9.57 731 | 31 | 9.61 076 | 36    | 0.38 924 | 9.96 655 | 5  | 48 |                  |
| 13 | 9.57 762 | 31 | 9.61 112 | 36    | 0.38 888 | 9.96 650 | 5  | 47 |                  |
| 14 | 9.57 793 | 31 | 9.61 148 | 36    | 0.38 852 | 9.96 645 | 5  | 46 | 32 31 30         |
| 15 | 9.57 824 | 31 | 9.61 184 | 36    | 0.38 816 | 9.96 640 | 5  | 45 | 1 3.2 3.1 3.0    |
| 16 | 9.57 855 | 30 | 9.61 220 | 36    | 0.38 780 | 9.96 634 | 4  | 44 | 2 6.4 6.2 6.0    |
| 17 | 9.57 885 | 31 | 9.61 256 | 36    | 0.38 744 | 9.96 629 | 5  | 43 | 3 9.6 9.3 9.0    |
| 18 | 9.57 916 | 31 | 9.61 292 | 36    | 0.38 708 | 9.96 624 | 5  | 42 | 4 12.8 12.4 12.0 |
| 19 | 9.57 947 | 31 | 9.61 328 | 36    | 0.38 672 | 9.96 619 | 5  | 41 | 5 16.0 15.5 15.0 |
| 20 | 9.57 978 | 30 | 9.61 364 | 36    | 0.38 636 | 9.96 614 | 5  | 40 | 6 19.2 18.6 18.0 |
| 21 | 9.58 008 | 31 | 9.61 400 | 36    | 0.38 600 | 9.96 608 | 3  | 39 | 7 22.4 21.7 21.0 |
| 22 | 9.58 039 | 31 | 9.61 436 | 36    | 0.38 564 | 9.96 603 | 3  | 38 | 8 25.6 24.8 24.0 |
| 23 | 9.58 070 | 31 | 9.61 472 | 36    | 0.38 528 | 9.96 598 | 3  | 37 | 9 28.8 27.9 27.0 |
| 24 | 9.58 101 | 30 | 9.61 508 | 36    | 0.38 492 | 9.96 593 | 3  | 36 |                  |
| 25 | 9.58 131 | 31 | 9.61 544 | 35    | 0.38 456 | 9.96 588 | 3  | 35 |                  |
| 26 | 9.58 162 | 31 | 9.61 579 | 36    | 0.38 421 | 9.96 582 | 3  | 34 | 29 6 5           |
| 27 | 9.58 192 | 31 | 9.61 615 | 36    | 0.38 385 | 9.96 577 | 3  | 33 | 1 2.9 0.6 0.5    |
| 28 | 9.58 223 | 30 | 9.61 651 | 36    | 0.38 349 | 9.96 572 | 3  | 32 | 2 5.8 1.2 1.0    |
| 29 | 9.58 253 | 31 | 9.61 687 | 35    | 0.38 313 | 9.96 567 | 3  | 31 | 3 8.7 1.8 1.5    |
| 30 | 9.58 284 | 30 | 9.61 722 | 36    | 0.38 278 | 9.96 562 | 3  | 30 | 4 11.6 2.4 2.0   |
| 31 | 9.58 314 | 31 | 9.61 758 | 36    | 0.38 242 | 9.96 556 | 3  | 29 | 5 14.5 3.0 2.5   |
| 32 | 9.58 345 | 31 | 9.61 794 | 36    | 0.38 206 | 9.96 551 | 3  | 28 | 6 17.4 3.6 3.0   |
| 33 | 9.58 375 | 31 | 9.61 830 | 35    | 0.38 170 | 9.96 546 | 3  | 27 | 7 20.3 4.2 3.5   |
| 34 | 9.58 406 | 30 | 9.61 865 | 36    | 0.38 135 | 9.96 541 | 3  | 26 | 8 23.2 4.8 4.0   |
| 35 | 9.58 436 | 31 | 9.61 901 | 35    | 0.38 099 | 9.96 535 | 3  | 25 | 9 26.1 5.4 4.5   |
| 36 | 9.58 467 | 31 | 9.61 936 | 36    | 0.38 064 | 9.96 530 | 3  | 24 |                  |
| 37 | 9.58 497 | 30 | 9.61 972 | 36    | 0.38 028 | 9.96 525 | 3  | 23 |                  |
| 38 | 9.58 527 | 30 | 9.62 008 | 35    | 0.37 992 | 9.96 520 | 3  | 22 |                  |
| 39 | 9.58 557 | 31 | 9.62 043 | 36    | 0.37 957 | 9.96 514 | 3  | 21 |                  |
| 40 | 9.58 588 | 30 | 9.62 079 | 35    | 0.37 921 | 9.96 509 | 3  | 20 | 6 6              |
| 41 | 9.58 618 | 30 | 9.62 114 | 36    | 0.37 886 | 9.96 504 | 3  | 19 | 36 35            |
| 42 | 9.58 648 | 30 | 9.62 150 | 35    | 0.37 850 | 9.96 498 | 3  | 18 | 0 3.0 2.9        |
| 43 | 9.58 678 | 31 | 9.62 185 | 36    | 0.37 815 | 9.96 493 | 3  | 17 | 1 9.0 8.8        |
| 44 | 9.58 709 | 30 | 9.62 221 | 35    | 0.37 779 | 9.96 488 | 3  | 16 | 2 15.0 14.6      |
| 45 | 9.58 739 | 30 | 9.62 256 | 36    | 0.37 744 | 9.96 483 | 3  | 15 | 3 21.0 20.4      |
| 46 | 9.58 769 | 30 | 9.62 292 | 35    | 0.37 708 | 9.96 477 | 3  | 14 | 4 27.0 26.2      |
| 47 | 9.58 799 | 30 | 9.62 327 | 36    | 0.37 673 | 9.96 472 | 3  | 13 | 5 33.0 32.1      |
| 48 | 9.58 829 | 30 | 9.62 362 | 35    | 0.37 638 | 9.96 467 | 3  | 12 |                  |
| 49 | 9.58 859 | 30 | 9.62 398 | 35    | 0.37 602 | 9.96 461 | 3  | 11 |                  |
| 50 | 9.58 889 | 30 | 9.62 433 | 35    | 0.37 567 | 9.96 456 | 3  | 10 |                  |
| 51 | 9.58 919 | 30 | 9.62 468 | 36    | 0.37 532 | 9.96 451 | 3  | 9  | 5 5 5            |
| 52 | 9.58 949 | 30 | 9.62 504 | 35    | 0.37 496 | 9.96 445 | 3  | 8  | 37 36 35         |
| 53 | 9.58 979 | 30 | 9.62 539 | 35    | 0.37 461 | 9.96 440 | 3  | 7  | 0 3.7 3.6 3.5    |
| 54 | 9.59 009 | 30 | 9.62 574 | 35    | 0.37 426 | 9.96 435 | 3  | 6  | 1 11.1 10.8 10.5 |
| 55 | 9.59 039 | 30 | 9.62 609 | 36    | 0.37 391 | 9.96 429 | 3  | 5  | 2 18.5 18.0 17.5 |
| 56 | 9.59 069 | 29 | 9.62 645 | 35    | 0.37 355 | 9.96 424 | 3  | 4  | 3 25.9 25.2 24.5 |
| 57 | 9.59 098 | 30 | 9.62 680 | 36    | 0.37 320 | 9.96 419 | 3  | 3  | 4 33.3 32.4 31.5 |
| 58 | 9.59 128 | 30 | 9.62 715 | 35    | 0.37 285 | 9.96 413 | 3  | 2  |                  |
| 59 | 9.59 158 | 30 | 9.62 750 | 35    | 0.37 250 | 9.96 408 | 3  | 1  |                  |
| 60 | 9.59 188 |    | 9.62 785 | 35    | 0.37 215 | 9.96 403 | 3  | 0  |                  |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P.            |

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18.5 18.0 17.5

22.2 21.6 21.0

25.9 25.2 24.5

29.6 28.8 28.0

33.3 32.4 31.5

32 31 30

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6.4 6.2 6.0

9.6 9.3 9.0

12.8 12.4 12.0

16.0 15.5 15.0

19.2 18.6 18.0

22.4 21.7 21.0

25.6 24.8 24.0

28.8 27.9 27.0

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14.5 3.0 2.5

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23.2 4.8 4.0

26.1 5.4 4.5

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21.0 20.4

27.0 26.2

33.0 32.1

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|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.            |
|----|----------|----|----------|-------|----------|----------|----|----|------------------|
| 0  | 9.59 188 | 30 | 9.62 785 | 35    | 0.37 213 | 9.96 403 | 6  | 60 |                  |
| 1  | 9.59 218 | 29 | 9.62 820 | 35    | 0.37 180 | 9.96 397 | 5  | 59 |                  |
| 2  | 9.59 247 | 30 | 9.62 855 | 35    | 0.37 145 | 9.96 392 | 5  | 58 |                  |
| 3  | 9.59 277 | 30 | 9.62 890 | 35    | 0.37 110 | 9.96 387 | 5  | 57 | 36 35 34         |
| 4  | 9.59 307 | 29 | 9.62 926 | 36    | 0.37 074 | 9.96 381 | 5  | 56 | 1 3.6 3.5 3.4    |
| 5  | 9.59 336 | 30 | 9.62 961 | 35    | 0.37 039 | 9.96 376 | 5  | 55 | 2 7.2 7.0 6.8    |
| 6  | 9.59 366 | 30 | 9.62 996 | 35    | 0.37 004 | 9.96 370 | 5  | 54 | 3 10.8 10.5 10.2 |
| 7  | 9.59 396 | 29 | 9.63 031 | 35    | 0.36 969 | 9.96 365 | 5  | 53 | 4 14.4 14.0 13.6 |
| 8  | 9.59 425 | 29 | 9.63 066 | 35    | 0.36 934 | 9.96 360 | 5  | 52 | 5 18.0 17.5 17.0 |
| 9  | 9.59 455 | 29 | 9.63 101 | 35    | 0.36 899 | 9.96 354 | 5  | 51 | 6 21.6 21.0 20.4 |
| 10 | 9.59 484 | 30 | 9.63 135 | 34    | 0.36 865 | 9.96 349 | 5  | 50 | 7 25.2 24.5 23.8 |
| 11 | 9.59 514 | 29 | 9.63 170 | 35    | 0.36 830 | 9.96 343 | 5  | 49 | 8 28.8 28.0 27.2 |
| 12 | 9.59 543 | 30 | 9.63 205 | 35    | 0.36 795 | 9.96 338 | 5  | 48 | 9 32.4 31.5 30.6 |
| 13 | 9.59 573 | 30 | 9.63 240 | 35    | 0.36 760 | 9.96 333 | 5  | 47 |                  |
| 14 | 9.59 602 | 29 | 9.63 275 | 35    | 0.36 725 | 9.96 327 | 5  | 46 |                  |
| 15 | 9.59 632 | 30 | 9.63 310 | 35    | 0.36 690 | 9.96 322 | 5  | 45 | 30 29 28         |
| 16 | 9.59 661 | 29 | 9.63 345 | 35    | 0.36 655 | 9.96 316 | 5  | 44 | 1 3.0 2.9 2.8    |
| 17 | 9.59 690 | 30 | 9.63 379 | 34    | 0.36 621 | 9.96 311 | 5  | 43 | 2 6.0 5.8 5.6    |
| 18 | 9.59 720 | 29 | 9.63 414 | 35    | 0.36 586 | 9.96 305 | 5  | 42 | 3 9.0 8.7 8.4    |
| 19 | 9.59 749 | 29 | 9.63 449 | 35    | 0.36 551 | 9.96 300 | 5  | 41 | 4 12.0 11.6 11.2 |
| 20 | 9.59 778 | 30 | 9.63 484 | 35    | 0.36 516 | 9.96 294 | 5  | 40 | 5 15.0 14.5 14.0 |
| 21 | 9.59 808 | 29 | 9.63 519 | 35    | 0.36 481 | 9.96 289 | 5  | 39 | 6 18.0 17.4 16.8 |
| 22 | 9.59 837 | 29 | 9.63 553 | 34    | 0.36 447 | 9.96 284 | 5  | 38 | 7 21.0 20.3 19.6 |
| 23 | 9.59 866 | 29 | 9.63 588 | 35    | 0.36 412 | 9.96 278 | 5  | 37 | 8 24.0 23.2 22.4 |
| 24 | 9.59 895 | 29 | 9.63 623 | 35    | 0.36 377 | 9.96 273 | 5  | 36 | 9 27.0 26.1 25.2 |
| 25 | 9.59 924 | 29 | 9.63 657 | 34    | 0.36 343 | 9.96 267 | 5  | 35 |                  |
| 26 | 9.59 954 | 30 | 9.63 692 | 35    | 0.36 308 | 9.96 262 | 5  | 34 |                  |
| 27 | 9.59 983 | 29 | 9.63 726 | 35    | 0.36 274 | 9.96 256 | 5  | 33 | 6 5              |
| 28 | 9.60 012 | 29 | 9.63 761 | 35    | 0.36 239 | 9.96 251 | 5  | 32 | 1 0.6 0.5        |
| 29 | 9.60 041 | 29 | 9.63 796 | 34    | 0.36 204 | 9.96 245 | 5  | 31 | 2 1.2 1.0        |
| 30 | 9.60 070 | 29 | 9.63 830 | 35    | 0.36 170 | 9.96 240 | 5  | 30 | 3 1.8 1.5        |
| 31 | 9.60 099 | 29 | 9.63 865 | 35    | 0.36 135 | 9.96 234 | 5  | 29 | 4 2.4 2.0        |
| 32 | 9.60 128 | 29 | 9.63 899 | 35    | 0.36 101 | 9.96 229 | 5  | 28 | 5 3.0 2.5        |
| 33 | 9.60 157 | 29 | 9.63 934 | 34    | 0.36 066 | 9.96 223 | 5  | 27 | 6 3.6 3.0        |
| 34 | 9.60 186 | 29 | 9.63 968 | 35    | 0.36 032 | 9.96 218 | 5  | 26 | 7 4.2 3.5        |
| 35 | 9.60 215 | 29 | 9.64 003 | 35    | 0.35 997 | 9.96 212 | 5  | 25 | 8 4.8 4.0        |
| 36 | 9.60 244 | 29 | 9.64 037 | 34    | 0.35 963 | 9.96 207 | 5  | 24 | 9 5.4 4.5        |
| 37 | 9.60 273 | 29 | 9.64 072 | 35    | 0.35 928 | 9.96 201 | 5  | 23 |                  |
| 38 | 9.60 302 | 29 | 9.64 106 | 34    | 0.35 894 | 9.96 196 | 5  | 22 |                  |
| 39 | 9.60 331 | 28 | 9.64 140 | 35    | 0.35 860 | 9.96 190 | 5  | 21 |                  |
| 40 | 9.60 359 | 29 | 9.64 175 | 35    | 0.35 825 | 9.96 185 | 5  | 20 |                  |
| 41 | 9.60 388 | 29 | 9.64 209 | 34    | 0.35 791 | 9.96 179 | 5  | 19 | 6 6 6            |
| 42 | 9.60 417 | 29 | 9.64 243 | 35    | 0.35 757 | 9.96 174 | 5  | 18 | 36 35 34         |
| 43 | 9.60 446 | 28 | 9.64 278 | 35    | 0.35 722 | 9.96 168 | 5  | 17 | 1 3.0 2.9 2.8    |
| 44 | 9.60 474 | 29 | 9.64 312 | 34    | 0.35 688 | 9.96 162 | 5  | 16 | 2 9.0 8.8 8.5    |
| 45 | 9.60 503 | 29 | 9.64 346 | 35    | 0.35 654 | 9.96 157 | 5  | 15 | 3 15.0 14.6 14.2 |
| 46 | 9.60 532 | 29 | 9.64 381 | 35    | 0.35 619 | 9.96 151 | 5  | 14 | 4 21.0 20.4 19.8 |
| 47 | 9.60 561 | 28 | 9.64 415 | 34    | 0.35 585 | 9.96 146 | 5  | 13 | 5 27.0 26.2 25.5 |
| 48 | 9.60 589 | 28 | 9.64 449 | 34    | 0.35 551 | 9.96 140 | 5  | 12 | 6 33.0 32.1 31.2 |
| 49 | 9.60 618 | 28 | 9.64 483 | 34    | 0.35 517 | 9.96 135 | 5  | 11 |                  |
| 50 | 9.60 646 | 29 | 9.64 517 | 35    | 0.35 483 | 9.96 129 | 5  | 10 |                  |
| 51 | 9.60 675 | 29 | 9.64 552 | 35    | 0.35 448 | 9.96 123 | 5  | 9  | 5 5              |
| 52 | 9.60 704 | 28 | 9.64 586 | 34    | 0.35 414 | 9.96 118 | 5  | 8  | 35 34            |
| 53 | 9.60 732 | 28 | 9.64 620 | 34    | 0.35 380 | 9.96 112 | 5  | 7  | 1 3.5 3.4        |
| 54 | 9.60 761 | 28 | 9.64 654 | 34    | 0.35 346 | 9.96 107 | 5  | 6  | 2 10.5 10.2      |
| 55 | 9.60 789 | 29 | 9.64 688 | 34    | 0.35 312 | 9.96 101 | 5  | 5  | 3 17.5 17.0      |
| 56 | 9.60 818 | 28 | 9.64 722 | 34    | 0.35 278 | 9.96 095 | 5  | 4  | 4 24.5 23.8      |
| 57 | 9.60 846 | 28 | 9.64 756 | 34    | 0.35 244 | 9.96 090 | 5  | 3  | 5 31.5 30.6      |
| 58 | 9.60 875 | 28 | 9.64 790 | 34    | 0.35 210 | 9.96 084 | 5  | 2  |                  |
| 59 | 9.60 903 | 28 | 9.64 824 | 34    | 0.35 176 | 9.96 079 | 5  | 1  |                  |
| 60 | 9.60 931 | 28 | 9.64 858 | 34    | 0.35 142 | 9.96 073 | 5  | 0  |                  |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P.            |



|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.            |
|----|----------|----|----------|-------|----------|----------|----|----|------------------|
| 0  | 9.60 931 | 29 | 9.64 858 | 34    | 0.35 142 | 9.96 073 | 6  | 60 |                  |
| 1  | 9.60 960 | 28 | 9.64 892 | 34    | 0.35 108 | 9.96 067 | 5  | 59 |                  |
| 2  | 9.60 988 | 28 | 9.64 926 | 34    | 0.35 074 | 9.96 062 | 5  | 58 |                  |
| 3  | 9.61 016 | 28 | 9.64 960 | 34    | 0.35 040 | 9.96 056 | 5  | 57 |                  |
| 4  | 9.61 043 | 29 | 9.64 994 | 34    | 0.35 006 | 9.96 050 | 5  | 56 | 34 33            |
| 5  | 9.61 073 | 28 | 9.65 028 | 34    | 0.34 972 | 9.96 045 | 5  | 55 | 1 3.4 3.3        |
| 6  | 9.61 101 | 28 | 9.65 062 | 34    | 0.34 938 | 9.96 039 | 5  | 54 | 2 6.8 6.6        |
| 7  | 9.61 129 | 29 | 9.65 096 | 34    | 0.34 904 | 9.96 034 | 5  | 53 | 3 10.2 9.9       |
| 8  | 9.61 158 | 28 | 9.65 130 | 34    | 0.34 870 | 9.96 028 | 5  | 52 | 4 13.6 13.2      |
| 9  | 9.61 186 | 28 | 9.65 164 | 34    | 0.34 836 | 9.96 022 | 5  | 51 | 5 17.0 16.5      |
| 10 | 9.61 214 | 28 | 9.65 197 | 33    | 0.34 803 | 9.96 017 | 5  | 50 | 6 20.4 19.8      |
| 11 | 9.61 242 | 28 | 9.65 231 | 34    | 0.34 769 | 9.96 011 | 6  | 49 | 7 23.8 23.1      |
| 12 | 9.61 270 | 28 | 9.65 265 | 34    | 0.34 735 | 9.96 005 | 6  | 48 | 8 27.2 26.4      |
| 13 | 9.61 298 | 28 | 9.65 299 | 34    | 0.34 701 | 9.96 000 | 6  | 47 | 9 30.6 29.7      |
| 14 | 9.61 326 | 28 | 9.65 333 | 34    | 0.34 667 | 9.95 994 | 6  | 46 |                  |
| 15 | 9.61 354 | 28 | 9.65 366 | 34    | 0.34 634 | 9.95 988 | 6  | 45 |                  |
| 16 | 9.61 382 | 29 | 9.65 400 | 34    | 0.34 600 | 9.95 982 | 5  | 44 |                  |
| 17 | 9.61 411 | 28 | 9.65 434 | 33    | 0.34 566 | 9.95 977 | 6  | 43 | 29 28 27         |
| 18 | 9.61 438 | 28 | 9.65 467 | 33    | 0.34 533 | 9.95 971 | 6  | 42 |                  |
| 19 | 9.61 466 | 28 | 9.65 501 | 34    | 0.34 499 | 9.95 965 | 6  | 41 | 1 2.9 2.8 2.7    |
| 20 | 9.61 494 | 28 | 9.65 535 | 34    | 0.34 465 | 9.95 960 | 6  | 40 | 2 5.8 5.6 5.4    |
| 21 | 9.61 522 | 28 | 9.65 568 | 33    | 0.34 432 | 9.95 954 | 6  | 39 | 3 8.7 8.4 8.1    |
| 22 | 9.61 550 | 28 | 9.65 602 | 34    | 0.34 398 | 9.95 948 | 6  | 38 | 4 11.6 11.2 10.8 |
| 23 | 9.61 578 | 28 | 9.65 636 | 34    | 0.34 364 | 9.95 942 | 6  | 37 | 5 14.5 14.0 13.5 |
| 24 | 9.61 606 | 28 | 9.65 669 | 33    | 0.34 331 | 9.95 937 | 5  | 36 | 6 17.4 16.8 16.2 |
| 25 | 9.61 634 | 28 | 9.65 703 | 34    | 0.34 297 | 9.95 931 | 6  | 35 | 7 20.3 19.6 18.9 |
| 26 | 9.61 662 | 27 | 9.65 736 | 33    | 0.34 264 | 9.95 925 | 6  | 34 | 8 23.2 22.4 21.6 |
| 27 | 9.61 689 | 28 | 9.65 770 | 34    | 0.34 230 | 9.95 920 | 6  | 33 | 9 26.1 25.2 24.3 |
| 28 | 9.61 717 | 28 | 9.65 803 | 33    | 0.34 197 | 9.95 914 | 6  | 32 |                  |
| 29 | 9.61 745 | 28 | 9.65 837 | 34    | 0.34 163 | 9.95 908 | 6  | 31 |                  |
| 30 | 9.61 773 | 27 | 9.65 870 | 33    | 0.34 130 | 9.95 902 | 5  | 30 |                  |
| 31 | 9.61 800 | 28 | 9.65 904 | 33    | 0.34 096 | 9.95 897 | 6  | 29 | 6 5              |
| 32 | 9.61 828 | 28 | 9.65 937 | 34    | 0.34 063 | 9.95 891 | 6  | 28 | 1 0.6 0.5        |
| 33 | 9.61 856 | 28 | 9.65 971 | 34    | 0.34 029 | 9.95 885 | 6  | 27 | 2 1.2 1.0        |
| 34 | 9.61 883 | 27 | 9.66 004 | 33    | 0.33 996 | 9.95 879 | 6  | 26 | 3 1.8 1.5        |
| 35 | 9.61 911 | 28 | 9.66 038 | 34    | 0.33 962 | 9.95 873 | 6  | 25 | 4 2.4 2.0        |
| 36 | 9.61 939 | 27 | 9.66 071 | 33    | 0.33 929 | 9.95 868 | 5  | 24 | 5 3.0 2.5        |
| 37 | 9.61 966 | 28 | 9.66 104 | 34    | 0.33 896 | 9.95 862 | 6  | 23 | 6 3.6 3.0        |
| 38 | 9.61 994 | 27 | 9.66 138 | 33    | 0.33 862 | 9.95 856 | 6  | 22 | 7 4.2 3.5        |
| 39 | 9.62 021 | 28 | 9.66 171 | 33    | 0.33 829 | 9.95 850 | 6  | 21 | 8 4.8 4.0        |
| 40 | 9.62 049 | 27 | 9.66 204 | 33    | 0.33 796 | 9.95 844 | 6  | 20 | 9 5.4 4.5        |
| 41 | 9.62 076 | 28 | 9.66 238 | 34    | 0.33 762 | 9.95 839 | 5  | 19 |                  |
| 42 | 9.62 104 | 28 | 9.66 271 | 33    | 0.33 729 | 9.95 833 | 6  | 18 |                  |
| 43 | 9.62 131 | 27 | 9.66 304 | 33    | 0.33 696 | 9.95 827 | 6  | 17 |                  |
| 44 | 9.62 159 | 28 | 9.66 337 | 34    | 0.33 663 | 9.95 821 | 6  | 16 |                  |
| 45 | 9.62 186 | 27 | 9.66 371 | 33    | 0.33 629 | 9.95 815 | 6  | 15 |                  |
| 46 | 9.62 214 | 28 | 9.66 404 | 33    | 0.33 596 | 9.95 810 | 5  | 14 |                  |
| 47 | 9.62 241 | 27 | 9.66 437 | 33    | 0.33 563 | 9.95 804 | 6  | 13 |                  |
| 48 | 9.62 268 | 28 | 9.66 470 | 33    | 0.33 530 | 9.95 798 | 6  | 12 |                  |
| 49 | 9.62 296 | 27 | 9.66 503 | 33    | 0.33 497 | 9.95 792 | 6  | 11 |                  |
| 50 | 9.62 323 | 27 | 9.66 537 | 33    | 0.33 463 | 9.95 786 | 6  | 10 | 6 6 5            |
| 51 | 9.62 350 | 27 | 9.66 570 | 33    | 0.33 430 | 9.95 780 | 5  | 9  | 34 33 34         |
| 52 | 9.62 377 | 28 | 9.66 603 | 33    | 0.33 397 | 9.95 775 | 5  | 8  | 0 2.8 2.8 3.4    |
| 53 | 9.62 405 | 27 | 9.66 636 | 33    | 0.33 364 | 9.95 769 | 6  | 7  | 1 8.5 8.2 10.2   |
| 54 | 9.62 432 | 27 | 9.66 669 | 33    | 0.33 331 | 9.95 763 | 6  | 6  | 2 14.2 13.8 17.0 |
| 55 | 9.62 459 | 27 | 9.66 702 | 33    | 0.33 298 | 9.95 757 | 6  | 5  | 3 19.8 19.2 23.8 |
| 56 | 9.62 486 | 27 | 9.66 735 | 33    | 0.33 265 | 9.95 751 | 6  | 4  | 4 25.5 24.8 30.6 |
| 57 | 9.62 513 | 28 | 9.66 768 | 33    | 0.33 232 | 9.95 745 | 6  | 3  | 5 31.2 30.2 —    |
| 58 | 9.62 541 | 27 | 9.66 801 | 33    | 0.33 199 | 9.95 739 | 6  | 2  |                  |
| 59 | 9.62 568 | 27 | 9.66 834 | 33    | 0.33 166 | 9.95 733 | 6  | 1  |                  |
| 60 | 9.62 595 | 27 | 9.66 867 | 33    | 0.33 133 | 9.95 728 | 5  | 0  |                  |
|    | L. Cos.  | d. | L. Tan.  | c. d. | L. Sin.  | d.       |    |    | P. P.            |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.            |
|----|----------|----|----------|-------|----------|----------|----|----|------------------|
| 0  | 9.62 593 | 27 | 9.66 867 | 33    | 0.33 133 | 9.95 728 | 6  | 60 |                  |
| 1  | 9.62 622 | 27 | 9.66 900 | 33    | 0.33 100 | 9.95 722 | 6  | 59 |                  |
| 2  | 9.62 649 | 27 | 9.66 933 | 33    | 0.33 067 | 9.95 716 | 6  | 58 |                  |
| 3  | 9.62 676 | 27 | 9.66 966 | 33    | 0.33 034 | 9.95 710 | 6  | 57 |                  |
| 4  | 9.62 703 | 27 | 9.66 999 | 33    | 0.33 001 | 9.95 704 | 6  | 56 | 33 32            |
| 5  | 9.62 730 | 27 | 9.67 032 | 33    | 0.32 968 | 9.95 698 | 6  | 55 | 1 3.3 3.2        |
| 6  | 9.62 757 | 27 | 9.67 065 | 33    | 0.32 935 | 9.95 692 | 6  | 54 | 2 6.6 6.4        |
| 7  | 9.62 784 | 27 | 9.67 098 | 33    | 0.32 902 | 9.95 686 | 6  | 53 | 3 9.9 9.6        |
| 8  | 9.62 811 | 27 | 9.67 131 | 33    | 0.32 869 | 9.95 680 | 6  | 52 | 4 13.2 12.8      |
| 9  | 9.62 838 | 27 | 9.67 163 | 32    | 0.32 837 | 9.95 674 | 6  | 51 | 5 16.5 16.0      |
| 10 | 9.62 865 | 27 | 9.67 196 | 33    | 0.32 804 | 9.95 668 | 6  | 50 | 6 19.8 19.2      |
| 11 | 9.62 892 | 27 | 9.67 229 | 33    | 0.32 771 | 9.95 663 | 5  | 49 | 7 23.1 22.4      |
| 12 | 9.62 918 | 27 | 9.67 262 | 33    | 0.32 738 | 9.95 657 | 6  | 48 | 8 26.4 25.6      |
| 13 | 9.62 945 | 27 | 9.67 295 | 33    | 0.32 705 | 9.95 651 | 6  | 47 | 9 29.7 28.8      |
| 14 | 9.62 972 | 27 | 9.67 327 | 32    | 0.32 673 | 9.95 645 | 6  | 46 |                  |
| 15 | 9.62 999 | 27 | 9.67 360 | 33    | 0.32 640 | 9.95 639 | 6  | 45 |                  |
| 16 | 9.63 026 | 26 | 9.67 393 | 33    | 0.32 607 | 9.95 633 | 6  | 44 |                  |
| 17 | 9.63 052 | 27 | 9.67 426 | 32    | 0.32 574 | 9.95 627 | 6  | 43 | 27 26            |
| 18 | 9.63 079 | 27 | 9.67 458 | 32    | 0.32 542 | 9.95 621 | 6  | 42 | 1 2.7 2.6        |
| 19 | 9.63 106 | 27 | 9.67 491 | 33    | 0.32 509 | 9.95 615 | 6  | 41 | 2 5.4 5.2        |
| 20 | 9.63 133 | 26 | 9.67 524 | 32    | 0.32 476 | 9.95 609 | 6  | 40 | 3 8.1 7.8        |
| 21 | 9.63 159 | 27 | 9.67 556 | 33    | 0.32 444 | 9.95 603 | 6  | 39 | 4 10.8 10.4      |
| 22 | 9.63 186 | 27 | 9.67 589 | 33    | 0.32 411 | 9.95 597 | 6  | 38 | 5 13.5 13.0      |
| 23 | 9.63 213 | 26 | 9.67 622 | 33    | 0.32 378 | 9.95 591 | 6  | 37 | 6 16.2 15.6      |
| 24 | 9.63 239 | 27 | 9.67 654 | 32    | 0.32 346 | 9.95 585 | 6  | 36 | 7 18.9 18.2      |
| 25 | 9.63 266 | 27 | 9.67 687 | 33    | 0.32 313 | 9.95 579 | 6  | 35 | 8 21.6 20.8      |
| 26 | 9.63 292 | 26 | 9.67 719 | 32    | 0.32 281 | 9.95 573 | 6  | 34 | 9 24.3 23.4      |
| 27 | 9.63 319 | 26 | 9.67 752 | 33    | 0.32 248 | 9.95 567 | 6  | 33 |                  |
| 28 | 9.63 345 | 27 | 9.67 785 | 33    | 0.32 215 | 9.95 561 | 6  | 32 |                  |
| 29 | 9.63 372 | 26 | 9.67 817 | 32    | 0.32 183 | 9.95 555 | 6  | 31 |                  |
| 30 | 9.63 398 | 27 | 9.67 850 | 33    | 0.32 150 | 9.95 549 | 6  | 30 | 7 6 5            |
| 31 | 9.63 425 | 26 | 9.67 882 | 32    | 0.32 118 | 9.95 543 | 6  | 29 | 1 0.7 0.6 0.5    |
| 32 | 9.63 451 | 27 | 9.67 915 | 33    | 0.32 085 | 9.95 537 | 6  | 28 | 2 1.4 1.2 1.0    |
| 33 | 9.63 478 | 26 | 9.67 947 | 32    | 0.32 053 | 9.95 531 | 6  | 27 | 3 2.1 1.8 1.5    |
| 34 | 9.63 504 | 27 | 9.67 980 | 33    | 0.32 020 | 9.95 525 | 6  | 26 | 4 2.8 2.4 2.0    |
| 35 | 9.63 531 | 26 | 9.68 012 | 32    | 0.31 988 | 9.95 519 | 6  | 25 | 5 3.5 3.0 2.5    |
| 36 | 9.63 557 | 26 | 9.68 044 | 33    | 0.31 956 | 9.95 513 | 6  | 24 | 6 4.2 3.6 3.0    |
| 37 | 9.63 583 | 27 | 9.68 077 | 32    | 0.31 923 | 9.95 507 | 7  | 23 | 7 4.9 4.2 3.5    |
| 38 | 9.63 610 | 26 | 9.68 109 | 33    | 0.31 891 | 9.95 500 | 7  | 22 | 8 5.6 4.8 4.0    |
| 39 | 9.63 636 | 26 | 9.68 142 | 32    | 0.31 858 | 9.95 494 | 6  | 21 | 9 6.3 5.4 4.5    |
| 40 | 9.63 662 | 27 | 9.68 174 | 33    | 0.31 826 | 9.95 488 | 6  | 20 |                  |
| 41 | 9.63 689 | 26 | 9.68 206 | 32    | 0.31 794 | 9.95 482 | 6  | 19 |                  |
| 42 | 9.63 715 | 26 | 9.68 239 | 33    | 0.31 761 | 9.95 476 | 6  | 18 |                  |
| 43 | 9.63 741 | 26 | 9.68 271 | 32    | 0.31 729 | 9.95 470 | 6  | 17 |                  |
| 44 | 9.63 767 | 27 | 9.68 303 | 33    | 0.31 697 | 9.95 464 | 6  | 16 |                  |
| 45 | 9.63 794 | 26 | 9.68 336 | 32    | 0.31 664 | 9.95 458 | 6  | 15 |                  |
| 46 | 9.63 820 | 26 | 9.68 368 | 33    | 0.31 632 | 9.95 452 | 6  | 14 |                  |
| 47 | 9.63 846 | 26 | 9.68 400 | 32    | 0.31 600 | 9.95 446 | 6  | 13 |                  |
| 48 | 9.63 872 | 26 | 9.68 432 | 33    | 0.31 568 | 9.95 440 | 6  | 12 |                  |
| 49 | 9.63 898 | 26 | 9.68 465 | 32    | 0.31 535 | 9.95 434 | 6  | 11 |                  |
| 50 | 9.63 924 | 26 | 9.68 497 | 33    | 0.31 503 | 9.95 427 | 7  | 10 | 0 2.3 2.7 3.3    |
| 51 | 9.63 950 | 26 | 9.68 529 | 32    | 0.31 471 | 9.95 421 | 6  | 9  | 1 6.9 8.0 9.9    |
| 52 | 9.63 976 | 26 | 9.68 561 | 33    | 0.31 439 | 9.95 415 | 6  | 8  | 2 11.4 13.3 16.5 |
| 53 | 9.64 002 | 26 | 9.68 593 | 32    | 0.31 407 | 9.95 409 | 6  | 7  | 3 16.0 18.7 23.1 |
| 54 | 9.64 028 | 26 | 9.68 626 | 33    | 0.31 374 | 9.95 403 | 6  | 6  | 4 20.6 24.0 29.7 |
| 55 | 9.64 054 | 26 | 9.68 658 | 32    | 0.31 342 | 9.95 397 | 6  | 5  | 5 25.1 29.3 —    |
| 56 | 9.64 080 | 26 | 9.68 690 | 33    | 0.31 310 | 9.95 391 | 6  | 4  | 6 29.7 — —       |
| 57 | 9.64 106 | 26 | 9.68 722 | 32    | 0.31 278 | 9.95 384 | 7  | 3  |                  |
| 58 | 9.64 132 | 26 | 9.68 754 | 33    | 0.31 246 | 9.95 378 | 6  | 2  |                  |
| 59 | 9.64 158 | 26 | 9.68 786 | 32    | 0.31 214 | 9.95 372 | 6  | 1  |                  |
| 60 | 9.64 184 | 26 | 9.68 818 | 33    | 0.31 182 | 9.95 366 | 6  | 0  |                  |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P.            |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.            |
|----|----------|----|----------|-------|----------|----------|----|----|------------------|
| 0  | 9.64 184 | 26 | 9.68 818 | 32    | 0.31 182 | 9.95 366 | 6  | 60 |                  |
| 1  | 9.64 210 | 26 | 9.68 850 | 32    | 0.31 150 | 9.95 360 | 6  | 59 |                  |
| 2  | 9.64 236 | 26 | 9.68 882 | 32    | 0.31 118 | 9.95 354 | 6  | 58 |                  |
| 3  | 9.64 262 | 26 | 9.68 914 | 32    | 0.31 086 | 9.95 348 | 6  | 57 |                  |
| 4  | 9.64 288 | 25 | 9.68 946 | 32    | 0.31 054 | 9.95 341 | 6  | 56 | 32 31            |
| 5  | 9.64 313 | 26 | 9.68 978 | 32    | 0.31 022 | 9.95 335 | 6  | 55 | 1 3.2 3.1        |
| 6  | 9.64 339 | 26 | 9.69 010 | 32    | 0.30 990 | 9.95 329 | 6  | 54 | 2 6.4 6.2        |
| 7  | 9.64 365 | 26 | 9.69 042 | 32    | 0.30 958 | 9.95 323 | 6  | 53 | 3 9.6 9.3        |
| 8  | 9.64 391 | 26 | 9.69 074 | 32    | 0.30 926 | 9.95 317 | 6  | 52 | 4 12.8 12.4      |
| 9  | 9.64 417 | 25 | 9.69 106 | 32    | 0.30 894 | 9.95 310 | 6  | 51 | 5 16.0 15.5      |
| 10 | 9.64 442 | 26 | 9.69 138 | 32    | 0.30 862 | 9.95 304 | 6  | 50 | 6 19.2 18.6      |
| 11 | 9.64 468 | 26 | 9.69 170 | 32    | 0.30 830 | 9.95 298 | 6  | 49 | 7 22.4 21.7      |
| 12 | 9.64 494 | 25 | 9.69 202 | 32    | 0.30 798 | 9.95 292 | 6  | 48 | 8 25.6 24.8      |
| 13 | 9.64 519 | 26 | 9.69 234 | 32    | 0.30 766 | 9.95 286 | 6  | 47 | 9 28.8 27.9      |
| 14 | 9.64 545 | 26 | 9.69 266 | 32    | 0.30 734 | 9.95 279 | 7  | 46 |                  |
| 15 | 9.64 571 | 25 | 9.69 298 | 31    | 0.30 702 | 9.95 273 | 6  | 45 |                  |
| 16 | 9.64 596 | 26 | 9.69 329 | 32    | 0.30 671 | 9.95 267 | 6  | 44 |                  |
| 17 | 9.64 622 | 25 | 9.69 361 | 32    | 0.30 639 | 9.95 261 | 7  | 43 | 26 25 24         |
| 18 | 9.64 647 | 26 | 9.69 393 | 32    | 0.30 607 | 9.95 254 | 7  | 42 | 1 2.6 2.5 2.4    |
| 19 | 9.64 673 | 25 | 9.69 425 | 32    | 0.30 575 | 9.95 248 | 6  | 41 | 2 5.2 5.0 4.8    |
| 20 | 9.64 698 | 26 | 9.69 457 | 31    | 0.30 543 | 9.95 242 | 6  | 40 | 3 7.8 7.5 7.2    |
| 21 | 9.64 724 | 25 | 9.69 488 | 32    | 0.30 512 | 9.95 236 | 7  | 39 | 4 10.4 10.0 9.6  |
| 22 | 9.64 749 | 26 | 9.69 520 | 32    | 0.30 480 | 9.95 229 | 7  | 38 | 5 13.0 12.5 12.0 |
| 23 | 9.64 775 | 25 | 9.69 552 | 32    | 0.30 448 | 9.95 223 | 6  | 37 | 6 15.6 15.0 14.4 |
| 24 | 9.64 800 | 26 | 9.69 584 | 31    | 0.30 416 | 9.95 217 | 6  | 36 | 7 18.2 17.5 16.8 |
| 25 | 9.64 826 | 25 | 9.69 615 | 32    | 0.30 385 | 9.95 211 | 7  | 35 | 8 20.8 20.0 19.2 |
| 26 | 9.64 851 | 26 | 9.69 647 | 32    | 0.30 353 | 9.95 204 | 6  | 34 | 9 23.4 22.5 21.6 |
| 27 | 9.64 877 | 25 | 9.69 679 | 31    | 0.30 321 | 9.95 198 | 6  | 33 |                  |
| 28 | 9.64 902 | 26 | 9.69 710 | 32    | 0.30 290 | 9.95 192 | 6  | 32 |                  |
| 29 | 9.64 927 | 25 | 9.69 742 | 32    | 0.30 258 | 9.95 185 | 7  | 31 |                  |
| 30 | 9.64 953 | 25 | 9.69 774 | 31    | 0.30 226 | 9.95 179 | 6  | 30 | 7 6              |
| 31 | 9.64 978 | 25 | 9.69 805 | 32    | 0.30 195 | 9.95 173 | 6  | 29 | 1 0.7 0.6        |
| 32 | 9.65 003 | 26 | 9.69 837 | 31    | 0.30 163 | 9.95 167 | 6  | 28 | 2 1.4 1.2        |
| 33 | 9.65 029 | 25 | 9.69 868 | 32    | 0.30 132 | 9.95 160 | 7  | 27 | 3 2.1 1.8        |
| 34 | 9.65 054 | 25 | 9.69 900 | 32    | 0.30 100 | 9.95 154 | 6  | 26 | 4 2.8 2.4        |
| 35 | 9.65 079 | 25 | 9.69 932 | 31    | 0.30 068 | 9.95 148 | 6  | 25 | 5 3.5 3.0        |
| 36 | 9.65 104 | 26 | 9.69 963 | 32    | 0.30 037 | 9.95 141 | 7  | 24 | 6 4.2 3.6        |
| 37 | 9.65 130 | 25 | 9.69 995 | 31    | 0.30 005 | 9.95 135 | 6  | 23 | 7 4.9 4.2        |
| 38 | 9.65 155 | 25 | 9.70 026 | 32    | 0.29 974 | 9.95 129 | 6  | 22 | 8 5.6 4.8        |
| 39 | 9.65 180 | 25 | 9.70 058 | 31    | 0.29 942 | 9.95 122 | 7  | 21 | 9 6.3 5.4        |
| 40 | 9.65 205 | 25 | 9.70 089 | 32    | 0.29 911 | 9.95 116 | 6  | 20 |                  |
| 41 | 9.65 230 | 25 | 9.70 121 | 31    | 0.29 879 | 9.95 110 | 6  | 19 |                  |
| 42 | 9.65 255 | 26 | 9.70 152 | 32    | 0.29 848 | 9.95 103 | 7  | 18 |                  |
| 43 | 9.65 281 | 25 | 9.70 184 | 31    | 0.29 816 | 9.95 097 | 6  | 17 |                  |
| 44 | 9.65 306 | 25 | 9.70 215 | 32    | 0.29 785 | 9.95 090 | 7  | 16 |                  |
| 45 | 9.65 331 | 25 | 9.70 247 | 31    | 0.29 753 | 9.95 084 | 6  | 15 |                  |
| 46 | 9.65 356 | 25 | 9.70 278 | 31    | 0.29 722 | 9.95 078 | 6  | 14 |                  |
| 47 | 9.65 381 | 25 | 9.70 309 | 32    | 0.29 691 | 9.95 071 | 7  | 13 |                  |
| 48 | 9.65 406 | 25 | 9.70 341 | 31    | 0.29 659 | 9.95 065 | 6  | 12 |                  |
| 49 | 9.65 431 | 25 | 9.70 372 | 32    | 0.29 628 | 9.95 059 | 6  | 11 |                  |
| 50 | 9.65 456 | 25 | 9.70 404 | 31    | 0.29 596 | 9.95 052 | 7  | 10 | 0 2.3 2.2 2.2    |
| 51 | 9.65 481 | 25 | 9.70 435 | 31    | 0.29 565 | 9.95 046 | 7  | 9  | 1 6.9 6.6 6.0    |
| 52 | 9.65 506 | 25 | 9.70 466 | 32    | 0.29 534 | 9.95 039 | 6  | 8  | 2 11.4 11.1 10.3 |
| 53 | 9.65 531 | 25 | 9.70 498 | 31    | 0.29 502 | 9.95 033 | 6  | 7  | 3 16.0 15.5 14.7 |
| 54 | 9.65 556 | 24 | 9.70 529 | 31    | 0.29 471 | 9.95 027 | 6  | 6  | 4 20.6 19.9 24.0 |
| 55 | 9.65 580 | 25 | 9.70 560 | 32    | 0.29 440 | 9.95 020 | 7  | 5  | 5 25.1 24.4 29.3 |
| 56 | 9.65 605 | 25 | 9.70 592 | 31    | 0.29 408 | 9.95 014 | 6  | 4  | 6 29.7 28.8 —    |
| 57 | 9.65 630 | 25 | 9.70 623 | 31    | 0.29 377 | 9.95 007 | 7  | 3  |                  |
| 58 | 9.65 655 | 25 | 9.70 654 | 31    | 0.29 346 | 9.95 001 | 6  | 2  |                  |
| 59 | 9.65 680 | 25 | 9.70 685 | 32    | 0.29 315 | 9.94 995 | 6  | 1  |                  |
| 60 | 9.65 705 |    | 9.70 717 |       | 0.29 283 | 9.94 988 | 7  | 0  |                  |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P.            |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.            |
|----|----------|----|----------|-------|----------|----------|----|----|------------------|
| 0  | 9.65 703 | 24 | 9.70 717 | 31    | 0.29 283 | 9.94 988 | 6  | 60 |                  |
| 1  | 9.65 729 | 25 | 9.70 748 | 31    | 0.29 252 | 9.94 982 | 6  | 59 |                  |
| 2  | 9.65 754 | 25 | 9.70 779 | 31    | 0.29 221 | 9.94 975 | 6  | 58 |                  |
| 3  | 9.65 779 | 25 | 9.70 810 | 31    | 0.29 190 | 9.94 969 | 7  | 57 |                  |
| 4  | 9.65 804 | 25 | 9.70 841 | 31    | 0.29 159 | 9.94 962 | 7  | 56 | 32 31 30         |
| 5  | 9.65 828 | 24 | 9.70 873 | 32    | 0.29 127 | 9.94 956 | 7  | 55 | 1 3.2 3.1 3.0    |
| 6  | 9.65 853 | 25 | 9.70 904 | 31    | 0.29 096 | 9.94 949 | 7  | 54 | 2 6.4 6.2 6.0    |
| 7  | 9.65 878 | 24 | 9.70 935 | 31    | 0.29 065 | 9.94 943 | 7  | 53 | 3 9.6 9.3 9.0    |
| 8  | 9.65 902 | 24 | 9.70 966 | 31    | 0.29 034 | 9.94 936 | 7  | 52 | 4 12.8 12.4 12.0 |
| 9  | 9.65 927 | 25 | 9.70 997 | 31    | 0.29 003 | 9.94 930 | 6  | 51 | 5 16.0 15.5 15.0 |
| 10 | 9.65 952 | 24 | 9.71 028 | 31    | 0.28 972 | 9.94 923 | 6  | 50 | 6 19.2 18.6 18.0 |
| 11 | 9.65 976 | 25 | 9.71 059 | 31    | 0.28 941 | 9.94 917 | 6  | 49 | 7 22.4 21.7 21.0 |
| 12 | 9.66 001 | 24 | 9.71 090 | 31    | 0.28 910 | 9.94 911 | 6  | 48 | 8 25.6 24.8 24.0 |
| 13 | 9.66 025 | 24 | 9.71 121 | 31    | 0.28 879 | 9.94 904 | 7  | 47 | 9 28.8 27.9 27.0 |
| 14 | 9.66 050 | 25 | 9.71 153 | 32    | 0.28 847 | 9.94 898 | 6  | 46 |                  |
| 15 | 9.66 075 | 25 | 9.71 184 | 31    | 0.28 816 | 9.94 891 | 6  | 45 |                  |
| 16 | 9.66 099 | 24 | 9.71 215 | 31    | 0.28 785 | 9.94 885 | 6  | 44 | 25 24 23         |
| 17 | 9.66 124 | 24 | 9.71 246 | 31    | 0.28 754 | 9.94 878 | 7  | 43 | 1 2.5 2.4 2.3    |
| 18 | 9.66 148 | 25 | 9.71 277 | 31    | 0.28 723 | 9.94 871 | 7  | 42 | 2 5.0 4.8 4.6    |
| 19 | 9.66 173 | 25 | 9.71 308 | 31    | 0.28 692 | 9.94 865 | 7  | 41 | 3 7.5 7.2 6.9    |
| 20 | 9.66 197 | 24 | 9.71 339 | 31    | 0.28 661 | 9.94 858 | 6  | 40 | 4 10.0 9.6 9.2   |
| 21 | 9.66 221 | 25 | 9.71 370 | 31    | 0.28 630 | 9.94 852 | 7  | 39 | 5 12.5 12.0 11.5 |
| 22 | 9.66 246 | 24 | 9.71 401 | 30    | 0.28 599 | 9.94 845 | 7  | 38 | 6 15.0 14.4 13.8 |
| 23 | 9.66 270 | 24 | 9.71 431 | 31    | 0.28 569 | 9.94 839 | 6  | 37 | 7 17.5 16.8 16.1 |
| 24 | 9.66 295 | 25 | 9.71 462 | 31    | 0.28 538 | 9.94 832 | 7  | 36 | 8 20.0 19.2 18.4 |
| 25 | 9.66 319 | 24 | 9.71 493 | 31    | 0.28 507 | 9.94 826 | 7  | 35 | 9 22.5 21.6 20.7 |
| 26 | 9.66 343 | 25 | 9.71 524 | 31    | 0.28 476 | 9.94 819 | 6  | 34 |                  |
| 27 | 9.66 368 | 24 | 9.71 555 | 31    | 0.28 445 | 9.94 813 | 7  | 33 |                  |
| 28 | 9.66 392 | 24 | 9.71 586 | 31    | 0.28 414 | 9.94 806 | 7  | 32 |                  |
| 29 | 9.66 416 | 25 | 9.71 617 | 31    | 0.28 383 | 9.94 799 | 7  | 31 |                  |
| 30 | 9.66 441 | 24 | 9.71 648 | 31    | 0.28 352 | 9.94 793 | 6  | 30 | 7 6              |
| 31 | 9.66 465 | 24 | 9.71 679 | 30    | 0.28 321 | 9.94 786 | 7  | 29 | 1 0.7 0.6        |
| 32 | 9.66 489 | 24 | 9.71 709 | 31    | 0.28 291 | 9.94 780 | 7  | 28 | 2 1.4 1.2        |
| 33 | 9.66 513 | 24 | 9.71 740 | 31    | 0.28 260 | 9.94 773 | 7  | 27 | 3 2.1 1.8        |
| 34 | 9.66 537 | 25 | 9.71 771 | 31    | 0.28 229 | 9.94 767 | 6  | 26 | 4 2.8 2.4        |
| 35 | 9.66 562 | 25 | 9.71 802 | 31    | 0.28 198 | 9.94 760 | 7  | 25 | 5 3.5 3.0        |
| 36 | 9.66 586 | 24 | 9.71 833 | 31    | 0.28 167 | 9.94 753 | 7  | 24 | 6 4.2 3.6        |
| 37 | 9.66 610 | 24 | 9.71 863 | 31    | 0.28 137 | 9.94 747 | 7  | 23 | 7 4.9 4.2        |
| 38 | 9.66 634 | 24 | 9.71 894 | 31    | 0.28 106 | 9.94 740 | 7  | 22 | 8 5.6 4.8        |
| 39 | 9.66 658 | 24 | 9.71 925 | 31    | 0.28 075 | 9.94 734 | 6  | 21 | 9 6.3 5.4        |
| 40 | 9.66 682 | 24 | 9.71 955 | 30    | 0.28 045 | 9.94 727 | 7  | 20 |                  |
| 41 | 9.66 706 | 25 | 9.71 986 | 31    | 0.28 014 | 9.94 720 | 7  | 19 |                  |
| 42 | 9.66 731 | 24 | 9.72 017 | 31    | 0.27 983 | 9.94 714 | 7  | 18 |                  |
| 43 | 9.66 755 | 24 | 9.72 048 | 31    | 0.27 952 | 9.94 707 | 7  | 17 |                  |
| 44 | 9.66 779 | 24 | 9.72 078 | 30    | 0.27 922 | 9.94 700 | 6  | 16 |                  |
| 45 | 9.66 803 | 24 | 9.72 109 | 31    | 0.27 891 | 9.94 694 | 6  | 15 |                  |
| 46 | 9.66 827 | 24 | 9.72 140 | 31    | 0.27 860 | 9.94 687 | 7  | 14 |                  |
| 47 | 9.66 851 | 24 | 9.72 170 | 30    | 0.27 830 | 9.94 680 | 6  | 13 |                  |
| 48 | 9.66 875 | 24 | 9.72 201 | 31    | 0.27 799 | 9.94 674 | 6  | 12 |                  |
| 49 | 9.66 899 | 23 | 9.72 231 | 31    | 0.27 769 | 9.94 667 | 7  | 11 |                  |
| 50 | 9.66 922 | 24 | 9.72 262 | 31    | 0.27 738 | 9.94 660 | 7  | 10 | 0 2.1 2.6 2.5    |
| 51 | 9.66 946 | 24 | 9.72 293 | 31    | 0.27 707 | 9.94 654 | 6  | 9  | 1 6.4 7.8 7.5    |
| 52 | 9.66 970 | 24 | 9.72 323 | 31    | 0.27 677 | 9.94 647 | 7  | 8  | 2 10.7 12.9 12.5 |
| 53 | 9.66 994 | 24 | 9.72 354 | 31    | 0.27 646 | 9.94 640 | 7  | 7  | 3 15.0 18.1 17.5 |
| 54 | 9.67 018 | 24 | 9.72 384 | 31    | 0.27 616 | 9.94 634 | 6  | 6  | 4 19.3 23.2 22.5 |
| 55 | 9.67 042 | 24 | 9.72 415 | 31    | 0.27 585 | 9.94 627 | 7  | 5  | 5 23.6 28.4 27.5 |
| 56 | 9.67 066 | 24 | 9.72 445 | 30    | 0.27 555 | 9.94 620 | 7  | 4  | 6 27.9 — —       |
| 57 | 9.67 090 | 23 | 9.72 476 | 31    | 0.27 524 | 9.94 614 | 7  | 3  |                  |
| 58 | 9.67 113 | 24 | 9.72 506 | 31    | 0.27 494 | 9.94 607 | 7  | 2  |                  |
| 59 | 9.67 137 | 24 | 9.72 537 | 30    | 0.27 463 | 9.94 600 | 7  | 1  |                  |
| 60 | 9.67 161 | 24 | 9.72 567 | 30    | 0.27 433 | 9.94 593 | 7  | 0  |                  |
|    | L. Cos.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Sin.  | d. |    | P. P.            |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. | P. P. |
|----|----------|----|----------|-------|----------|----------|----|-------|
| 0  | 9.67 161 | 24 | 9.72 567 | 31    | 0.27 433 | 9.94 593 | 6  | 60    |
| 1  | 9.67 185 | 23 | 9.72 598 | 30    | 0.27 402 | 9.94 587 | 7  | 59    |
| 2  | 9.67 208 | 23 | 9.72 628 | 31    | 0.27 372 | 9.94 580 | 7  | 58    |
| 3  | 9.67 232 | 24 | 9.72 659 | 30    | 0.27 341 | 9.94 573 | 7  | 57    |
| 4  | 9.67 256 | 24 | 9.72 689 | 30    | 0.27 311 | 9.94 567 | 7  | 56    |
| 5  | 9.67 280 | 24 | 9.72 720 | 31    | 0.27 280 | 9.94 560 | 7  | 55    |
| 6  | 9.67 303 | 23 | 9.72 750 | 30    | 0.27 250 | 9.94 553 | 7  | 54    |
| 7  | 9.67 327 | 23 | 9.72 780 | 30    | 0.27 220 | 9.94 546 | 6  | 53    |
| 8  | 9.67 350 | 23 | 9.72 811 | 31    | 0.27 189 | 9.94 540 | 7  | 52    |
| 9  | 9.67 374 | 24 | 9.72 841 | 31    | 0.27 159 | 9.94 533 | 7  | 51    |
| 10 | 9.67 398 | 23 | 9.72 872 | 30    | 0.27 128 | 9.94 526 | 7  | 50    |
| 11 | 9.67 421 | 24 | 9.72 902 | 30    | 0.27 098 | 9.94 519 | 6  | 49    |
| 12 | 9.67 445 | 23 | 9.72 932 | 31    | 0.27 068 | 9.94 513 | 7  | 48    |
| 13 | 9.67 468 | 23 | 9.72 963 | 30    | 0.27 037 | 9.94 506 | 7  | 47    |
| 14 | 9.67 492 | 24 | 9.72 993 | 30    | 0.27 007 | 9.94 499 | 7  | 46    |
| 15 | 9.67 515 | 23 | 9.73 023 | 31    | 0.26 977 | 9.94 492 | 7  | 45    |
| 16 | 9.67 539 | 23 | 9.73 054 | 30    | 0.26 946 | 9.94 485 | 6  | 44    |
| 17 | 9.67 562 | 24 | 9.73 084 | 30    | 0.26 916 | 9.94 479 | 7  | 43    |
| 18 | 9.67 586 | 23 | 9.73 114 | 30    | 0.26 886 | 9.94 472 | 7  | 42    |
| 19 | 9.67 609 | 23 | 9.73 144 | 31    | 0.26 856 | 9.94 465 | 7  | 41    |
| 20 | 9.67 633 | 24 | 9.73 175 | 30    | 0.26 825 | 9.94 458 | 7  | 40    |
| 21 | 9.67 656 | 23 | 9.73 205 | 30    | 0.26 795 | 9.94 451 | 6  | 39    |
| 22 | 9.67 680 | 23 | 9.73 235 | 30    | 0.26 765 | 9.94 445 | 7  | 38    |
| 23 | 9.67 703 | 23 | 9.73 265 | 30    | 0.26 735 | 9.94 438 | 7  | 37    |
| 24 | 9.67 726 | 23 | 9.73 295 | 30    | 0.26 705 | 9.94 431 | 7  | 36    |
| 25 | 9.67 750 | 24 | 9.73 326 | 31    | 0.26 674 | 9.94 424 | 7  | 35    |
| 26 | 9.67 773 | 23 | 9.73 356 | 30    | 0.26 644 | 9.94 417 | 7  | 34    |
| 27 | 9.67 796 | 24 | 9.73 386 | 30    | 0.26 614 | 9.94 410 | 6  | 33    |
| 28 | 9.67 820 | 23 | 9.73 416 | 30    | 0.26 584 | 9.94 404 | 7  | 32    |
| 29 | 9.67 843 | 23 | 9.73 446 | 30    | 0.26 554 | 9.94 397 | 7  | 31    |
| 30 | 9.67 866 | 24 | 9.73 476 | 31    | 0.26 524 | 9.94 390 | 7  | 30    |
| 31 | 9.67 890 | 23 | 9.73 507 | 30    | 0.26 493 | 9.94 383 | 7  | 29    |
| 32 | 9.67 913 | 23 | 9.73 537 | 30    | 0.26 463 | 9.94 376 | 7  | 28    |
| 33 | 9.67 936 | 23 | 9.73 567 | 30    | 0.26 433 | 9.94 369 | 7  | 27    |
| 34 | 9.67 959 | 23 | 9.73 597 | 30    | 0.26 403 | 9.94 362 | 7  | 26    |
| 35 | 9.67 982 | 23 | 9.73 627 | 30    | 0.26 373 | 9.94 355 | 7  | 25    |
| 36 | 9.68 006 | 24 | 9.73 657 | 30    | 0.26 343 | 9.94 349 | 6  | 24    |
| 37 | 9.68 029 | 23 | 9.73 687 | 30    | 0.26 313 | 9.94 342 | 7  | 23    |
| 38 | 9.68 052 | 23 | 9.73 717 | 30    | 0.26 283 | 9.94 335 | 7  | 22    |
| 39 | 9.68 075 | 23 | 9.73 747 | 30    | 0.26 253 | 9.94 328 | 7  | 21    |
| 40 | 9.68 098 | 23 | 9.73 777 | 30    | 0.26 223 | 9.94 321 | 7  | 20    |
| 41 | 9.68 121 | 23 | 9.73 807 | 30    | 0.26 193 | 9.94 314 | 7  | 19    |
| 42 | 9.68 144 | 23 | 9.73 837 | 30    | 0.26 163 | 9.94 307 | 7  | 18    |
| 43 | 9.68 167 | 23 | 9.73 867 | 30    | 0.26 133 | 9.94 300 | 7  | 17    |
| 44 | 9.68 190 | 23 | 9.73 897 | 30    | 0.26 103 | 9.94 293 | 7  | 16    |
| 45 | 9.68 213 | 23 | 9.73 927 | 30    | 0.26 073 | 9.94 286 | 7  | 15    |
| 46 | 9.68 237 | 24 | 9.73 957 | 30    | 0.26 043 | 9.94 279 | 6  | 14    |
| 47 | 9.68 260 | 23 | 9.73 987 | 30    | 0.26 013 | 9.94 273 | 7  | 13    |
| 48 | 9.68 283 | 22 | 9.74 017 | 30    | 0.25 983 | 9.94 266 | 7  | 12    |
| 49 | 9.68 305 | 23 | 9.74 047 | 30    | 0.25 953 | 9.94 259 | 7  | 11    |
| 50 | 9.68 328 | 23 | 9.74 077 | 30    | 0.25 923 | 9.94 252 | 7  | 10    |
| 51 | 9.68 351 | 23 | 9.74 107 | 30    | 0.25 893 | 9.94 245 | 7  | 9     |
| 52 | 9.68 374 | 23 | 9.74 137 | 29    | 0.25 863 | 9.94 238 | 7  | 8     |
| 53 | 9.68 397 | 23 | 9.74 166 | 30    | 0.25 834 | 9.94 231 | 7  | 7     |
| 54 | 9.68 420 | 23 | 9.74 196 | 30    | 0.25 804 | 9.94 224 | 7  | 6     |
| 55 | 9.68 443 | 23 | 9.74 226 | 30    | 0.25 774 | 9.94 217 | 7  | 5     |
| 56 | 9.68 466 | 23 | 9.74 256 | 30    | 0.25 744 | 9.94 210 | 7  | 4     |
| 57 | 9.68 489 | 23 | 9.74 286 | 30    | 0.25 714 | 9.94 203 | 7  | 3     |
| 58 | 9.68 512 | 22 | 9.74 316 | 29    | 0.25 684 | 9.94 196 | 7  | 2     |
| 59 | 9.68 534 | 23 | 9.74 345 | 30    | 0.25 653 | 9.94 189 | 7  | 1     |
| 60 | 9.68 557 |    | 9.74 375 |       | 0.25 623 | 9.94 182 |    | 0     |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. | P. P. |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P. |
|----|----------|----|----------|-------|----------|----------|----|----|-------|
| 0  | 9.68 557 | 23 | 9.74 375 | 30    | 0.25 623 | 9.94 182 | 7  | 60 |       |
| 1  | 9.68 580 | 23 | 9.74 405 | 30    | 0.25 595 | 9.94 175 | 7  | 59 |       |
| 2  | 9.68 603 | 22 | 9.74 435 | 30    | 0.25 565 | 9.94 168 | 7  | 58 |       |
| 3  | 9.68 625 | 22 | 9.74 465 | 30    | 0.25 535 | 9.94 161 | 7  | 57 |       |
| 4  | 9.68 648 | 23 | 9.74 494 | 29    | 0.25 506 | 9.94 154 | 7  | 56 |       |
| 5  | 9.68 671 | 23 | 9.74 524 | 30    | 0.25 476 | 9.94 147 | 7  | 55 |       |
| 6  | 9.68 694 | 22 | 9.74 554 | 29    | 0.25 446 | 9.94 140 | 7  | 54 |       |
| 7  | 9.68 716 | 23 | 9.74 583 | 30    | 0.25 417 | 9.94 133 | 7  | 53 |       |
| 8  | 9.68 739 | 23 | 9.74 613 | 30    | 0.25 387 | 9.94 126 | 7  | 52 |       |
| 9  | 9.68 762 | 22 | 9.74 643 | 30    | 0.25 357 | 9.94 119 | 7  | 51 |       |
| 10 | 9.68 784 | 23 | 9.74 673 | 29    | 0.25 327 | 9.94 112 | 7  | 50 |       |
| 11 | 9.68 807 | 22 | 9.74 702 | 30    | 0.25 298 | 9.94 105 | 7  | 49 |       |
| 12 | 9.68 829 | 23 | 9.74 732 | 30    | 0.25 268 | 9.94 098 | 7  | 48 |       |
| 13 | 9.68 852 | 23 | 9.74 762 | 30    | 0.25 238 | 9.94 090 | 7  | 47 |       |
| 14 | 9.68 875 | 22 | 9.74 791 | 29    | 0.25 209 | 9.94 083 | 7  | 46 |       |
| 15 | 9.68 897 | 23 | 9.74 821 | 30    | 0.25 179 | 9.94 076 | 7  | 45 |       |
| 16 | 9.68 920 | 23 | 9.74 851 | 29    | 0.25 149 | 9.94 069 | 7  | 44 |       |
| 17 | 9.68 942 | 23 | 9.74 880 | 30    | 0.25 120 | 9.94 062 | 7  | 43 |       |
| 18 | 9.68 965 | 22 | 9.74 910 | 30    | 0.25 090 | 9.94 055 | 7  | 42 |       |
| 19 | 9.68 987 | 23 | 9.74 939 | 29    | 0.25 061 | 9.94 048 | 7  | 41 |       |
| 20 | 9.69 010 | 22 | 9.74 969 | 29    | 0.25 031 | 9.94 041 | 7  | 40 |       |
| 21 | 9.69 032 | 23 | 9.74 998 | 30    | 0.25 002 | 9.94 034 | 7  | 39 |       |
| 22 | 9.69 055 | 22 | 9.75 028 | 30    | 0.24 972 | 9.94 027 | 7  | 38 |       |
| 23 | 9.69 077 | 23 | 9.75 058 | 29    | 0.24 942 | 9.94 020 | 8  | 37 |       |
| 24 | 9.69 100 | 23 | 9.75 087 | 29    | 0.24 913 | 9.94 012 | 7  | 36 |       |
| 25 | 9.69 122 | 22 | 9.75 117 | 30    | 0.24 883 | 9.94 005 | 7  | 35 |       |
| 26 | 9.69 144 | 23 | 9.75 146 | 29    | 0.24 854 | 9.93 998 | 7  | 34 |       |
| 27 | 9.69 167 | 22 | 9.75 176 | 29    | 0.24 824 | 9.93 991 | 7  | 33 |       |
| 28 | 9.69 189 | 23 | 9.75 205 | 29    | 0.24 795 | 9.93 984 | 7  | 32 |       |
| 29 | 9.69 212 | 22 | 9.75 235 | 30    | 0.24 765 | 9.93 977 | 7  | 31 |       |
| 30 | 9.69 234 | 23 | 9.75 264 | 30    | 0.24 736 | 9.93 970 | 7  | 30 |       |
| 31 | 9.69 256 | 22 | 9.75 294 | 29    | 0.24 706 | 9.93 963 | 8  | 29 |       |
| 32 | 9.69 279 | 23 | 9.75 323 | 30    | 0.24 677 | 9.93 955 | 7  | 28 |       |
| 33 | 9.69 301 | 22 | 9.75 353 | 29    | 0.24 647 | 9.93 948 | 7  | 27 |       |
| 34 | 9.69 323 | 22 | 9.75 382 | 29    | 0.24 618 | 9.93 941 | 7  | 26 |       |
| 35 | 9.69 345 | 23 | 9.75 411 | 29    | 0.24 589 | 9.93 934 | 7  | 25 |       |
| 36 | 9.69 368 | 22 | 9.75 441 | 29    | 0.24 559 | 9.93 927 | 7  | 24 |       |
| 37 | 9.69 390 | 22 | 9.75 470 | 30    | 0.24 530 | 9.93 920 | 8  | 23 |       |
| 38 | 9.69 412 | 23 | 9.75 500 | 29    | 0.24 500 | 9.93 912 | 7  | 22 |       |
| 39 | 9.69 434 | 22 | 9.75 529 | 29    | 0.24 471 | 9.93 905 | 7  | 21 |       |
| 40 | 9.69 456 | 23 | 9.75 558 | 30    | 0.24 442 | 9.93 898 | 7  | 20 |       |
| 41 | 9.69 479 | 22 | 9.75 588 | 29    | 0.24 412 | 9.93 891 | 7  | 19 |       |
| 42 | 9.69 501 | 22 | 9.75 617 | 30    | 0.24 383 | 9.93 884 | 7  | 18 |       |
| 43 | 9.69 523 | 23 | 9.75 647 | 29    | 0.24 353 | 9.93 876 | 7  | 17 |       |
| 44 | 9.69 545 | 22 | 9.75 676 | 29    | 0.24 324 | 9.93 869 | 7  | 16 |       |
| 45 | 9.69 567 | 22 | 9.75 705 | 30    | 0.24 295 | 9.93 862 | 7  | 15 |       |
| 46 | 9.69 589 | 22 | 9.75 735 | 29    | 0.24 265 | 9.93 855 | 8  | 14 |       |
| 47 | 9.69 611 | 22 | 9.75 764 | 29    | 0.24 236 | 9.93 847 | 7  | 13 |       |
| 48 | 9.69 633 | 22 | 9.75 793 | 30    | 0.24 207 | 9.93 840 | 7  | 12 |       |
| 49 | 9.69 655 | 22 | 9.75 822 | 29    | 0.24 178 | 9.93 833 | 7  | 11 |       |
| 50 | 9.69 677 | 22 | 9.75 852 | 29    | 0.24 148 | 9.93 826 | 7  | 10 |       |
| 51 | 9.69 699 | 22 | 9.75 881 | 29    | 0.24 119 | 9.93 819 | 7  | 9  |       |
| 52 | 9.69 721 | 22 | 9.75 910 | 29    | 0.24 090 | 9.93 811 | 7  | 8  |       |
| 53 | 9.69 743 | 22 | 9.75 939 | 29    | 0.24 061 | 9.93 804 | 7  | 7  |       |
| 54 | 9.69 765 | 22 | 9.75 969 | 30    | 0.24 031 | 9.93 797 | 8  | 6  |       |
| 55 | 9.69 787 | 22 | 9.75 998 | 29    | 0.24 002 | 9.93 789 | 7  | 5  |       |
| 56 | 9.69 809 | 22 | 9.76 027 | 29    | 0.23 973 | 9.93 782 | 7  | 4  |       |
| 57 | 9.69 831 | 23 | 9.76 056 | 30    | 0.23 944 | 9.93 775 | 7  | 3  |       |
| 58 | 9.69 853 | 22 | 9.76 086 | 29    | 0.23 914 | 9.93 768 | 7  | 2  |       |
| 59 | 9.69 875 | 22 | 9.76 115 | 29    | 0.23 885 | 9.93 760 | 7  | 1  |       |
| 60 | 9.69 897 | 22 | 9.76 144 | 29    | 0.23 856 | 9.93 753 | 7  | 0  |       |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Sin.  | d.       |    |    | P. P. |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.            |
|----|----------|----|----------|-------|----------|----------|----|----|------------------|
| 0  | 9.69 897 | 22 | 9.76 144 | 29    | 0.23 856 | 9.93 753 | 7  | 60 |                  |
| 1  | 9.69 919 | 22 | 9.76 173 | 29    | 0.23 827 | 9.93 746 | 8  | 59 |                  |
| 2  | 9.69 941 | 22 | 9.76 202 | 29    | 0.23 798 | 9.93 738 | 7  | 58 |                  |
| 3  | 9.69 963 | 21 | 9.76 231 | 30    | 0.23 769 | 9.93 731 | 7  | 57 |                  |
| 4  | 9.69 984 | 22 | 9.76 261 | 29    | 0.23 739 | 9.93 724 | 7  | 56 | 30 29 28         |
| 5  | 9.70 006 | 22 | 9.76 290 | 29    | 0.23 710 | 9.93 717 | 8  | 55 | 1 3.0 2.9 2.8    |
| 6  | 9.70 028 | 22 | 9.76 319 | 29    | 0.23 681 | 9.93 709 | 7  | 54 | 2 6.0 5.8 5.6    |
| 7  | 9.70 050 | 22 | 9.76 348 | 29    | 0.23 652 | 9.93 702 | 7  | 53 | 3 9.0 8.7 8.4    |
| 8  | 9.70 072 | 21 | 9.76 377 | 29    | 0.23 623 | 9.93 695 | 7  | 52 | 4 12.0 11.6 11.2 |
| 9  | 9.70 093 | 22 | 9.76 406 | 29    | 0.23 594 | 9.93 687 | 8  | 51 | 5 15.0 14.5 14.0 |
| 10 | 9.70 115 | 22 | 9.76 435 | 29    | 0.23 565 | 9.93 680 | 7  | 50 | 6 18.0 17.4 16.8 |
| 11 | 9.70 137 | 22 | 9.76 464 | 29    | 0.23 536 | 9.93 673 | 7  | 49 | 7 21.0 20.3 19.6 |
| 12 | 9.70 159 | 21 | 9.76 493 | 29    | 0.23 507 | 9.93 665 | 8  | 48 | 8 24.0 23.2 22.4 |
| 13 | 9.70 180 | 22 | 9.76 522 | 29    | 0.23 478 | 9.93 658 | 7  | 47 | 9 27.0 26.1 25.2 |
| 14 | 9.70 202 | 22 | 9.76 551 | 29    | 0.23 449 | 9.93 650 | 8  | 46 |                  |
| 15 | 9.70 224 | 21 | 9.76 580 | 29    | 0.23 420 | 9.93 643 | 7  | 45 |                  |
| 16 | 9.70 245 | 22 | 9.76 609 | 30    | 0.23 391 | 9.93 636 | 7  | 44 |                  |
| 17 | 9.70 267 | 21 | 9.76 639 | 29    | 0.23 361 | 9.93 628 | 8  | 43 | 22 21            |
| 18 | 9.70 288 | 22 | 9.76 668 | 29    | 0.23 332 | 9.93 621 | 7  | 42 | 1 2.2 2.1        |
| 19 | 9.70 310 | 22 | 9.76 697 | 28    | 0.23 303 | 9.93 614 | 8  | 41 | 2 4.4 4.2        |
| 20 | 9.70 332 | 21 | 9.76 725 | 29    | 0.23 275 | 9.93 606 | 7  | 40 | 3 6.6 6.3        |
| 21 | 9.70 353 | 22 | 9.76 754 | 29    | 0.23 246 | 9.93 599 | 7  | 39 | 4 8.8 8.4        |
| 22 | 9.70 375 | 21 | 9.76 783 | 29    | 0.23 217 | 9.93 591 | 8  | 38 | 5 11.0 10.5      |
| 23 | 9.70 396 | 22 | 9.76 812 | 29    | 0.23 188 | 9.93 584 | 7  | 37 | 6 13.2 12.6      |
| 24 | 9.70 418 | 21 | 9.76 841 | 29    | 0.23 159 | 9.93 577 | 8  | 36 | 7 15.4 14.7      |
| 25 | 9.70 439 | 22 | 9.76 870 | 29    | 0.23 130 | 9.93 569 | 7  | 35 | 8 17.6 16.8      |
| 26 | 9.70 461 | 21 | 9.76 899 | 29    | 0.23 101 | 9.93 562 | 8  | 34 | 9 19.8 18.9      |
| 27 | 9.70 482 | 22 | 9.76 928 | 29    | 0.23 072 | 9.93 554 | 7  | 33 |                  |
| 28 | 9.70 504 | 21 | 9.76 957 | 29    | 0.23 043 | 9.93 547 | 8  | 32 |                  |
| 29 | 9.70 525 | 22 | 9.76 986 | 29    | 0.23 014 | 9.93 539 | 7  | 31 |                  |
| 30 | 9.70 547 | 21 | 9.77 015 | 29    | 0.22 985 | 9.93 532 | 8  | 30 | 8 7              |
| 31 | 9.70 568 | 22 | 9.77 044 | 29    | 0.22 956 | 9.93 525 | 7  | 29 | 1 0.8 0.7        |
| 32 | 9.70 590 | 21 | 9.77 073 | 28    | 0.22 927 | 9.93 517 | 8  | 28 | 2 1.6 1.4        |
| 33 | 9.70 611 | 22 | 9.77 101 | 29    | 0.22 899 | 9.93 510 | 7  | 27 | 3 2.4 2.1        |
| 34 | 9.70 633 | 21 | 9.77 130 | 29    | 0.22 870 | 9.93 502 | 8  | 26 | 4 3.2 2.8        |
| 35 | 9.70 654 | 22 | 9.77 159 | 29    | 0.22 841 | 9.93 495 | 7  | 25 | 5 4.0 3.5        |
| 36 | 9.70 675 | 21 | 9.77 188 | 29    | 0.22 812 | 9.93 487 | 8  | 24 | 6 4.8 4.2        |
| 37 | 9.70 697 | 22 | 9.77 217 | 29    | 0.22 783 | 9.93 480 | 7  | 23 | 7 5.6 4.9        |
| 38 | 9.70 718 | 21 | 9.77 246 | 28    | 0.22 754 | 9.93 472 | 8  | 22 | 8 6.4 5.6        |
| 39 | 9.70 739 | 22 | 9.77 274 | 29    | 0.22 726 | 9.93 465 | 7  | 21 | 9 7.2 6.3        |
| 40 | 9.70 761 | 21 | 9.77 303 | 29    | 0.22 697 | 9.93 457 | 8  | 20 |                  |
| 41 | 9.70 782 | 22 | 9.77 332 | 29    | 0.22 668 | 9.93 450 | 7  | 19 |                  |
| 42 | 9.70 803 | 21 | 9.77 361 | 29    | 0.22 639 | 9.93 442 | 8  | 18 |                  |
| 43 | 9.70 824 | 22 | 9.77 390 | 28    | 0.22 610 | 9.93 435 | 7  | 17 |                  |
| 44 | 9.70 846 | 21 | 9.77 418 | 29    | 0.22 582 | 9.93 427 | 8  | 16 |                  |
| 45 | 9.70 867 | 22 | 9.77 447 | 29    | 0.22 553 | 9.93 420 | 7  | 15 |                  |
| 46 | 9.70 888 | 21 | 9.77 476 | 29    | 0.22 524 | 9.93 412 | 8  | 14 |                  |
| 47 | 9.70 909 | 22 | 9.77 505 | 28    | 0.22 495 | 9.93 405 | 7  | 13 | 7 7 7            |
| 48 | 9.70 931 | 21 | 9.77 533 | 29    | 0.22 467 | 9.93 397 | 8  | 12 | 30 29 28         |
| 49 | 9.70 952 | 22 | 9.77 562 | 29    | 0.22 438 | 9.93 390 | 7  | 11 |                  |
| 50 | 9.70 973 | 21 | 9.77 591 | 28    | 0.22 409 | 9.93 382 | 8  | 10 | 0 2.1 2.1 2.0    |
| 51 | 9.70 994 | 22 | 9.77 619 | 29    | 0.22 381 | 9.93 375 | 7  | 9  | 2 6.4 6.2 6.0    |
| 52 | 9.71 015 | 21 | 9.77 648 | 29    | 0.22 352 | 9.93 367 | 8  | 8  | 3 10.7 10.4 10.0 |
| 53 | 9.71 036 | 22 | 9.77 677 | 29    | 0.22 323 | 9.93 360 | 7  | 7  | 4 15.0 14.5 14.0 |
| 54 | 9.71 058 | 21 | 9.77 706 | 28    | 0.22 294 | 9.93 352 | 8  | 6  | 5 19.3 18.6 18.0 |
| 55 | 9.71 079 | 22 | 9.77 734 | 29    | 0.22 266 | 9.93 344 | 7  | 5  | 6 23.6 22.8 22.0 |
| 56 | 9.71 100 | 21 | 9.77 763 | 28    | 0.22 237 | 9.93 337 | 8  | 4  | 7 27.9 26.9 26.0 |
| 57 | 9.71 121 | 22 | 9.77 791 | 29    | 0.22 209 | 9.93 329 | 7  | 3  |                  |
| 58 | 9.71 142 | 21 | 9.77 820 | 29    | 0.22 180 | 9.93 322 | 8  | 2  |                  |
| 59 | 9.71 163 | 22 | 9.77 849 | 28    | 0.22 151 | 9.93 314 | 7  | 1  |                  |
| 60 | 9.71 184 |    | 9.77 877 |       | 0.22 123 | 9.93 307 |    | 0  |                  |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P.            |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.       |
|----|----------|----|----------|-------|----------|----------|----|----|-------------|
| 0  | 9.71 184 | 21 | 9.77 877 | 29    | 0.22 123 | 9.93 307 | 8  | 60 |             |
| 1  | 9.71 205 | 21 | 9.77 906 | 29    | 0.22 094 | 9.93 299 | 8  | 59 |             |
| 2  | 9.71 226 | 21 | 9.77 935 | 28    | 0.22 065 | 9.93 291 | 7  | 58 |             |
| 3  | 9.71 247 | 21 | 9.77 963 | 28    | 0.22 037 | 9.93 284 | 8  | 57 |             |
| 4  | 9.71 268 | 21 | 9.77 992 | 28    | 0.22 008 | 9.93 276 | 7  | 56 | 29 28       |
| 5  | 9.71 289 | 21 | 9.78 020 | 29    | 0.21 980 | 9.93 269 | 7  | 55 | 1 2.9 2.8   |
| 6  | 9.71 310 | 21 | 9.78 049 | 28    | 0.21 951 | 9.93 261 | 8  | 54 | 2 5.8 5.6   |
| 7  | 9.71 331 | 21 | 9.78 077 | 29    | 0.21 923 | 9.93 253 | 7  | 53 | 3 8.7 8.4   |
| 8  | 9.71 352 | 21 | 9.78 106 | 29    | 0.21 894 | 9.93 246 | 8  | 52 | 4 11.6 11.2 |
| 9  | 9.71 373 | 20 | 9.78 135 | 28    | 0.21 865 | 9.93 238 | 8  | 51 | 5 14.5 14.0 |
| 10 | 9.71 393 | 21 | 9.78 163 | 29    | 0.21 837 | 9.93 230 | 7  | 50 | 6 17.4 16.8 |
| 11 | 9.71 414 | 21 | 9.78 192 | 28    | 0.21 808 | 9.93 223 | 8  | 49 | 7 20.3 19.6 |
| 12 | 9.71 435 | 21 | 9.78 220 | 29    | 0.21 780 | 9.93 215 | 8  | 48 | 8 23.2 22.4 |
| 13 | 9.71 456 | 21 | 9.78 249 | 28    | 0.21 751 | 9.93 207 | 7  | 47 | 9 26.1 25.2 |
| 14 | 9.71 477 | 21 | 9.78 277 | 29    | 0.21 723 | 9.93 200 | 8  | 46 |             |
| 15 | 9.71 498 | 21 | 9.78 306 | 28    | 0.21 694 | 9.93 192 | 8  | 45 |             |
| 16 | 9.71 519 | 20 | 9.78 334 | 29    | 0.21 666 | 9.93 184 | 7  | 44 | 21 20       |
| 17 | 9.71 539 | 21 | 9.78 363 | 28    | 0.21 637 | 9.93 177 | 8  | 43 |             |
| 18 | 9.71 560 | 21 | 9.78 391 | 28    | 0.21 609 | 9.93 169 | 8  | 42 | 1 2.1 2.0   |
| 19 | 9.71 581 | 21 | 9.78 419 | 29    | 0.21 581 | 9.93 161 | 7  | 41 | 2 4.2 4.0   |
| 20 | 9.71 602 | 20 | 9.78 448 | 28    | 0.21 552 | 9.93 154 | 8  | 40 | 3 6.3 6.0   |
| 21 | 9.71 622 | 21 | 9.78 476 | 29    | 0.21 524 | 9.93 146 | 8  | 39 | 4 8.4 8.0   |
| 22 | 9.71 643 | 21 | 9.78 505 | 28    | 0.21 495 | 9.93 138 | 7  | 38 | 5 10.5 10.0 |
| 23 | 9.71 664 | 21 | 9.78 533 | 29    | 0.21 467 | 9.93 131 | 8  | 37 | 6 12.6 12.0 |
| 24 | 9.71 685 | 21 | 9.78 562 | 28    | 0.21 438 | 9.93 123 | 8  | 36 | 7 14.7 14.0 |
| 25 | 9.71 705 | 21 | 9.78 590 | 28    | 0.21 410 | 9.93 115 | 7  | 35 | 8 16.8 16.0 |
| 26 | 9.71 726 | 21 | 9.78 618 | 29    | 0.21 382 | 9.93 108 | 8  | 34 | 9 18.9 18.0 |
| 27 | 9.71 747 | 21 | 9.78 647 | 28    | 0.21 353 | 9.93 100 | 8  | 33 |             |
| 28 | 9.71 767 | 21 | 9.78 675 | 29    | 0.21 325 | 9.93 092 | 8  | 32 |             |
| 29 | 9.71 788 | 21 | 9.78 704 | 28    | 0.21 296 | 9.93 084 | 7  | 31 |             |
| 30 | 9.71 809 | 20 | 9.78 732 | 28    | 0.21 268 | 9.93 077 | 8  | 30 | 8 7         |
| 31 | 9.71 829 | 21 | 9.78 760 | 29    | 0.21 240 | 9.93 069 | 8  | 29 | 1 0.8 0.7   |
| 32 | 9.71 850 | 20 | 9.78 789 | 28    | 0.21 211 | 9.93 061 | 8  | 28 | 2 1.6 1.4   |
| 33 | 9.71 870 | 21 | 9.78 817 | 28    | 0.21 183 | 9.93 053 | 7  | 27 | 3 2.4 2.1   |
| 34 | 9.71 891 | 21 | 9.78 845 | 29    | 0.21 155 | 9.93 046 | 8  | 26 | 4 3.2 2.8   |
| 35 | 9.71 911 | 21 | 9.78 874 | 28    | 0.21 126 | 9.93 038 | 8  | 25 | 5 4.0 3.5   |
| 36 | 9.71 932 | 21 | 9.78 902 | 28    | 0.21 098 | 9.93 030 | 8  | 24 | 6 4.8 4.2   |
| 37 | 9.71 952 | 21 | 9.78 930 | 29    | 0.21 070 | 9.93 022 | 8  | 23 | 7 5.6 4.9   |
| 38 | 9.71 973 | 21 | 9.78 959 | 28    | 0.21 041 | 9.93 014 | 7  | 22 | 8 6.4 5.6   |
| 39 | 9.71 994 | 20 | 9.78 987 | 28    | 0.21 013 | 9.93 007 | 8  | 21 | 9 7.2 6.3   |
| 40 | 9.72 014 | 21 | 9.79 015 | 28    | 0.20 985 | 9.92 999 | 8  | 20 |             |
| 41 | 9.72 034 | 21 | 9.79 043 | 29    | 0.20 957 | 9.92 991 | 8  | 19 |             |
| 42 | 9.72 055 | 20 | 9.79 072 | 28    | 0.20 928 | 9.92 983 | 7  | 18 |             |
| 43 | 9.72 075 | 21 | 9.79 100 | 28    | 0.20 900 | 9.92 976 | 8  | 17 |             |
| 44 | 9.72 096 | 21 | 9.79 128 | 28    | 0.20 872 | 9.92 968 | 8  | 16 |             |
| 45 | 9.72 116 | 21 | 9.79 156 | 29    | 0.20 844 | 9.92 960 | 8  | 15 |             |
| 46 | 9.72 137 | 21 | 9.79 185 | 28    | 0.20 815 | 9.92 952 | 8  | 14 |             |
| 47 | 9.72 157 | 21 | 9.79 213 | 28    | 0.20 787 | 9.92 944 | 8  | 13 |             |
| 48 | 9.72 177 | 21 | 9.79 241 | 28    | 0.20 759 | 9.92 936 | 7  | 12 |             |
| 49 | 9.72 198 | 21 | 9.79 269 | 28    | 0.20 731 | 9.92 929 | 8  | 11 |             |
| 50 | 9.72 218 | 20 | 9.79 297 | 29    | 0.20 703 | 9.92 921 | 8  | 10 |             |
| 51 | 9.72 238 | 21 | 9.79 326 | 28    | 0.20 674 | 9.92 913 | 8  | 9  |             |
| 52 | 9.72 259 | 20 | 9.79 354 | 28    | 0.20 646 | 9.92 905 | 8  | 8  |             |
| 53 | 9.72 279 | 20 | 9.79 382 | 28    | 0.20 618 | 9.92 897 | 8  | 7  |             |
| 54 | 9.72 299 | 21 | 9.79 410 | 28    | 0.20 590 | 9.92 889 | 8  | 6  |             |
| 55 | 9.72 320 | 20 | 9.79 438 | 28    | 0.20 562 | 9.92 881 | 7  | 5  |             |
| 56 | 9.72 340 | 20 | 9.79 466 | 29    | 0.20 534 | 9.92 874 | 8  | 4  |             |
| 57 | 9.72 360 | 21 | 9.79 495 | 28    | 0.20 505 | 9.92 866 | 8  | 3  |             |
| 58 | 9.72 381 | 21 | 9.79 523 | 28    | 0.20 477 | 9.92 858 | 8  | 2  |             |
| 59 | 9.72 401 | 20 | 9.79 551 | 28    | 0.20 449 | 9.92 850 | 8  | 1  |             |
| 60 | 9.72 421 | 20 | 9.79 579 | 28    | 0.20 421 | 9.92 842 | 8  | 0  |             |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Sin.  | d.       |    |    | P. P.       |



|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.            |
|----|----------|----|----------|-------|----------|----------|----|----|------------------|
| 0  | 9.72 421 | 20 | 9.79 579 | 28    | 0.20 421 | 9.92 842 | 8  | 60 |                  |
| 1  | 9.72 441 | 20 | 9.79 607 | 28    | 0.20 393 | 9.92 834 | 8  | 59 |                  |
| 2  | 9.72 461 | 21 | 9.79 635 | 28    | 0.20 365 | 9.92 826 | 8  | 58 |                  |
| 3  | 9.72 482 | 20 | 9.79 663 | 28    | 0.20 337 | 9.92 818 | 8  | 57 |                  |
| 4  | 9.72 502 | 20 | 9.79 691 | 28    | 0.20 309 | 9.92 810 | 7  | 56 | 29 28 27         |
| 5  | 9.72 522 | 20 | 9.79 719 | 28    | 0.20 281 | 9.92 803 | 8  | 55 | 1 2.9 2.8 2.7    |
| 6  | 9.72 542 | 20 | 9.79 747 | 29    | 0.20 253 | 9.92 795 | 8  | 54 | 2 5.8 5.6 5.4    |
| 7  | 9.72 562 | 20 | 9.79 776 | 28    | 0.20 224 | 9.92 787 | 8  | 53 | 3 8.7 8.4 8.1    |
| 8  | 9.72 582 | 20 | 9.79 804 | 28    | 0.20 196 | 9.92 779 | 8  | 52 | 4 11.6 11.2 10.8 |
| 9  | 9.72 602 | 20 | 9.79 832 | 28    | 0.20 168 | 9.92 771 | 8  | 51 | 5 14.5 14.0 13.5 |
| 10 | 9.72 622 | 21 | 9.79 860 | 28    | 0.20 140 | 9.92 763 | 8  | 50 | 6 17.4 16.8 16.2 |
| 11 | 9.72 643 | 20 | 9.79 888 | 28    | 0.20 112 | 9.92 755 | 8  | 49 | 7 20.3 19.6 18.9 |
| 12 | 9.72 663 | 20 | 9.79 916 | 28    | 0.20 084 | 9.92 747 | 8  | 48 | 8 23.2 22.4 21.6 |
| 13 | 9.72 683 | 20 | 9.79 944 | 28    | 0.20 056 | 9.92 739 | 8  | 47 | 9 26.1 25.2 24.3 |
| 14 | 9.72 703 | 20 | 9.79 972 | 28    | 0.20 028 | 9.92 731 | 8  | 46 |                  |
| 15 | 9.72 723 | 20 | 9.80 000 | 28    | 0.20 000 | 9.92 723 | 8  | 45 |                  |
| 16 | 9.72 743 | 20 | 9.80 028 | 28    | 0.19 972 | 9.92 715 | 8  | 44 |                  |
| 17 | 9.72 763 | 20 | 9.80 056 | 28    | 0.19 944 | 9.92 707 | 8  | 43 | 21 20 19         |
| 18 | 9.72 783 | 20 | 9.80 084 | 28    | 0.19 916 | 9.92 699 | 8  | 42 | 1 2.1 2.0 1.9    |
| 19 | 9.72 803 | 20 | 9.80 112 | 28    | 0.19 888 | 9.92 691 | 8  | 41 | 2 4.2 4.0 3.8    |
| 20 | 9.72 823 | 20 | 9.80 140 | 28    | 0.19 860 | 9.92 683 | 8  | 40 | 3 6.3 6.0 5.7    |
| 21 | 9.72 843 | 20 | 9.80 168 | 27    | 0.19 832 | 9.92 675 | 8  | 39 | 4 8.4 8.0 7.6    |
| 22 | 9.72 863 | 20 | 9.80 195 | 28    | 0.19 805 | 9.92 667 | 8  | 38 | 5 10.5 10.0 9.5  |
| 23 | 9.72 883 | 20 | 9.80 223 | 28    | 0.19 777 | 9.92 659 | 8  | 37 | 6 12.6 12.0 11.4 |
| 24 | 9.72 902 | 19 | 9.80 251 | 28    | 0.19 749 | 9.92 651 | 8  | 36 | 7 14.7 14.0 13.3 |
| 25 | 9.72 922 | 20 | 9.80 279 | 28    | 0.19 721 | 9.92 643 | 8  | 35 | 8 16.8 16.0 15.2 |
| 26 | 9.72 942 | 20 | 9.80 307 | 28    | 0.19 693 | 9.92 635 | 8  | 34 | 9 18.9 18.0 17.1 |
| 27 | 9.72 962 | 20 | 9.80 335 | 28    | 0.19 665 | 9.92 627 | 8  | 33 |                  |
| 28 | 9.72 982 | 20 | 9.80 363 | 28    | 0.19 637 | 9.92 619 | 8  | 32 |                  |
| 29 | 9.73 002 | 20 | 9.80 391 | 28    | 0.19 609 | 9.92 611 | 8  | 31 |                  |
| 30 | 9.73 022 | 19 | 9.80 419 | 28    | 0.19 581 | 9.92 603 | 8  | 30 | 9 8 7            |
| 31 | 9.73 041 | 20 | 9.80 447 | 27    | 0.19 553 | 9.92 595 | 8  | 29 | 1 0.9 0.8 0.7    |
| 32 | 9.73 061 | 20 | 9.80 474 | 28    | 0.19 526 | 9.92 587 | 8  | 28 | 2 1.8 1.6 1.4    |
| 33 | 9.73 081 | 20 | 9.80 502 | 28    | 0.19 498 | 9.92 579 | 8  | 27 | 3 2.7 2.4 2.1    |
| 34 | 9.73 101 | 20 | 9.80 530 | 28    | 0.19 470 | 9.92 571 | 8  | 26 | 4 3.6 3.2 2.8    |
| 35 | 9.73 121 | 19 | 9.80 558 | 28    | 0.19 442 | 9.92 563 | 8  | 25 | 5 4.5 4.0 3.5    |
| 36 | 9.73 140 | 20 | 9.80 586 | 28    | 0.19 414 | 9.92 555 | 8  | 24 | 6 5.4 4.8 4.2    |
| 37 | 9.73 160 | 20 | 9.80 614 | 28    | 0.19 386 | 9.92 546 | 9  | 23 | 7 6.3 5.6 4.9    |
| 38 | 9.73 180 | 20 | 9.80 642 | 28    | 0.19 358 | 9.92 538 | 8  | 22 | 8 7.2 6.4 5.6    |
| 39 | 9.73 200 | 19 | 9.80 669 | 27    | 0.19 331 | 9.92 530 | 8  | 21 | 9 8.1 7.2 6.3    |
| 40 | 9.73 219 | 20 | 9.80 697 | 28    | 0.19 303 | 9.92 522 | 8  | 20 |                  |
| 41 | 9.73 239 | 20 | 9.80 725 | 28    | 0.19 275 | 9.92 514 | 8  | 19 |                  |
| 42 | 9.73 259 | 20 | 9.80 753 | 28    | 0.19 247 | 9.92 506 | 8  | 18 |                  |
| 43 | 9.73 278 | 19 | 9.80 781 | 28    | 0.19 219 | 9.92 498 | 8  | 17 |                  |
| 44 | 9.73 298 | 20 | 9.80 808 | 27    | 0.19 192 | 9.92 490 | 8  | 16 |                  |
| 45 | 9.73 318 | 19 | 9.80 836 | 28    | 0.19 164 | 9.92 482 | 8  | 15 |                  |
| 46 | 9.73 337 | 20 | 9.80 864 | 28    | 0.19 136 | 9.92 473 | 9  | 14 |                  |
| 47 | 9.73 357 | 20 | 9.80 892 | 28    | 0.19 108 | 9.92 465 | 8  | 13 |                  |
| 48 | 9.73 377 | 19 | 9.80 919 | 27    | 0.19 081 | 9.92 457 | 8  | 12 | 8 8 7            |
| 49 | 9.73 396 | 20 | 9.80 947 | 28    | 0.19 053 | 9.92 449 | 8  | 11 | 29 28 28         |
| 50 | 9.73 416 | 19 | 9.80 975 | 28    | 0.19 025 | 9.92 441 | 8  | 10 |                  |
| 51 | 9.73 435 | 20 | 9.81 003 | 27    | 0.18 997 | 9.92 433 | 8  | 9  | 1 1.8 1.8 2.0    |
| 52 | 9.73 455 | 19 | 9.81 030 | 28    | 0.18 970 | 9.92 425 | 8  | 8  | 2 5.4 5.2 6.0    |
| 53 | 9.73 474 | 20 | 9.81 058 | 28    | 0.18 942 | 9.92 416 | 9  | 7  | 3 9.1 8.8 10.0   |
| 54 | 9.73 494 | 19 | 9.81 086 | 28    | 0.18 914 | 9.92 408 | 8  | 6  | 4 12.7 12.2 14.0 |
| 55 | 9.73 513 | 20 | 9.81 113 | 27    | 0.18 887 | 9.92 400 | 8  | 5  | 5 16.3 15.8 18.0 |
| 56 | 9.73 533 | 19 | 9.81 141 | 28    | 0.18 859 | 9.92 392 | 8  | 4  | 6 19.9 19.2 22.0 |
| 57 | 9.73 552 | 20 | 9.81 169 | 28    | 0.18 831 | 9.92 384 | 8  | 3  | 7 23.6 22.8 26.0 |
| 58 | 9.73 572 | 19 | 9.81 196 | 27    | 0.18 804 | 9.92 376 | 9  | 2  | 8 27.2 26.2 —    |
| 59 | 9.73 591 | 20 | 9.81 224 | 28    | 0.18 776 | 9.92 367 | 8  | 1  |                  |
| 60 | 9.73 611 | 20 | 9.81 252 | 28    | 0.18 748 | 9.92 359 | 8  | 0  |                  |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P.            |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P. |
|----|----------|----|----------|-------|----------|----------|----|----|-------|
| 0  | 9.73 611 | 19 | 9.81 252 | 27    | 0.18 748 | 9.92 359 | 8  | 60 |       |
| 1  | 9.73 630 | 20 | 9.81 279 | 28    | 0.18 721 | 9.92 351 | 8  | 59 |       |
| 2  | 9.73 650 | 19 | 9.81 307 | 28    | 0.18 693 | 9.92 343 | 8  | 58 |       |
| 3  | 9.73 669 | 19 | 9.81 335 | 27    | 0.18 665 | 9.92 335 | 8  | 57 |       |
| 4  | 9.73 689 | 20 | 9.81 362 | 27    | 0.18 638 | 9.92 326 | 8  | 56 |       |
| 5  | 9.73 708 | 19 | 9.81 390 | 28    | 0.18 610 | 9.92 318 | 8  | 55 |       |
| 6  | 9.73 727 | 20 | 9.81 418 | 27    | 0.18 582 | 9.92 310 | 8  | 54 |       |
| 7  | 9.73 747 | 19 | 9.81 445 | 28    | 0.18 555 | 9.92 302 | 8  | 53 |       |
| 8  | 9.73 766 | 19 | 9.81 473 | 27    | 0.18 527 | 9.92 293 | 8  | 52 |       |
| 9  | 9.73 785 | 20 | 9.81 500 | 28    | 0.18 500 | 9.92 285 | 8  | 51 |       |
| 10 | 9.73 805 | 19 | 9.81 528 | 28    | 0.18 472 | 9.92 277 | 8  | 50 |       |
| 11 | 9.73 824 | 19 | 9.81 556 | 27    | 0.18 444 | 9.92 269 | 8  | 49 |       |
| 12 | 9.73 843 | 20 | 9.81 583 | 28    | 0.18 417 | 9.92 260 | 8  | 48 |       |
| 13 | 9.73 863 | 19 | 9.81 611 | 27    | 0.18 389 | 9.92 252 | 8  | 47 |       |
| 14 | 9.73 882 | 19 | 9.81 638 | 28    | 0.18 362 | 9.92 244 | 8  | 46 |       |
| 15 | 9.73 901 | 20 | 9.81 666 | 27    | 0.18 334 | 9.92 235 | 8  | 45 |       |
| 16 | 9.73 921 | 19 | 9.81 693 | 28    | 0.18 307 | 9.92 227 | 8  | 44 |       |
| 17 | 9.73 940 | 19 | 9.81 721 | 27    | 0.18 279 | 9.92 219 | 8  | 43 |       |
| 18 | 9.73 959 | 19 | 9.81 748 | 28    | 0.18 252 | 9.92 211 | 8  | 42 |       |
| 19 | 9.73 978 | 19 | 9.81 776 | 27    | 0.18 224 | 9.92 202 | 8  | 41 |       |
| 20 | 9.73 997 | 20 | 9.81 803 | 28    | 0.18 197 | 9.92 194 | 8  | 40 |       |
| 21 | 9.74 017 | 19 | 9.81 831 | 27    | 0.18 169 | 9.92 186 | 8  | 39 |       |
| 22 | 9.74 036 | 19 | 9.81 858 | 28    | 0.18 142 | 9.92 177 | 8  | 38 |       |
| 23 | 9.74 055 | 19 | 9.81 886 | 27    | 0.18 114 | 9.92 169 | 8  | 37 |       |
| 24 | 9.74 074 | 19 | 9.81 913 | 28    | 0.18 087 | 9.92 161 | 8  | 36 |       |
| 25 | 9.74 093 | 20 | 9.81 941 | 27    | 0.18 059 | 9.92 152 | 8  | 35 |       |
| 26 | 9.74 113 | 19 | 9.81 968 | 28    | 0.18 032 | 9.92 144 | 8  | 34 |       |
| 27 | 9.74 132 | 19 | 9.81 996 | 27    | 0.18 004 | 9.92 136 | 8  | 33 |       |
| 28 | 9.74 151 | 19 | 9.82 023 | 28    | 0.17 977 | 9.92 127 | 8  | 32 |       |
| 29 | 9.74 170 | 19 | 9.82 051 | 27    | 0.17 949 | 9.92 119 | 8  | 31 |       |
| 30 | 9.74 189 | 19 | 9.82 078 | 28    | 0.17 922 | 9.92 111 | 8  | 30 |       |
| 31 | 9.74 208 | 19 | 9.82 106 | 27    | 0.17 894 | 9.92 102 | 8  | 29 |       |
| 32 | 9.74 227 | 19 | 9.82 133 | 28    | 0.17 867 | 9.92 094 | 8  | 28 |       |
| 33 | 9.74 246 | 19 | 9.82 161 | 27    | 0.17 839 | 9.92 086 | 8  | 27 |       |
| 34 | 9.74 265 | 19 | 9.82 188 | 28    | 0.17 812 | 9.92 077 | 8  | 26 |       |
| 35 | 9.74 284 | 19 | 9.82 215 | 27    | 0.17 785 | 9.92 069 | 8  | 25 |       |
| 36 | 9.74 303 | 19 | 9.82 243 | 28    | 0.17 757 | 9.92 060 | 8  | 24 |       |
| 37 | 9.74 322 | 19 | 9.82 270 | 27    | 0.17 730 | 9.92 052 | 8  | 23 |       |
| 38 | 9.74 341 | 19 | 9.82 298 | 28    | 0.17 702 | 9.92 044 | 8  | 22 |       |
| 39 | 9.74 360 | 19 | 9.82 325 | 27    | 0.17 675 | 9.92 035 | 8  | 21 |       |
| 40 | 9.74 379 | 19 | 9.82 352 | 28    | 0.17 648 | 9.92 027 | 8  | 20 |       |
| 41 | 9.74 398 | 19 | 9.82 380 | 27    | 0.17 620 | 9.92 018 | 8  | 19 |       |
| 42 | 9.74 417 | 19 | 9.82 407 | 28    | 0.17 593 | 9.92 010 | 8  | 18 |       |
| 43 | 9.74 436 | 19 | 9.82 435 | 27    | 0.17 565 | 9.92 002 | 8  | 17 |       |
| 44 | 9.74 455 | 19 | 9.82 462 | 28    | 0.17 538 | 9.91 993 | 8  | 16 |       |
| 45 | 9.74 474 | 19 | 9.82 489 | 27    | 0.17 511 | 9.91 985 | 8  | 15 |       |
| 46 | 9.74 493 | 19 | 9.82 517 | 28    | 0.17 483 | 9.91 976 | 8  | 14 |       |
| 47 | 9.74 512 | 19 | 9.82 544 | 27    | 0.17 456 | 9.91 968 | 8  | 13 |       |
| 48 | 9.74 531 | 19 | 9.82 571 | 28    | 0.17 429 | 9.91 959 | 8  | 12 |       |
| 49 | 9.74 549 | 18 | 9.82 599 | 27    | 0.17 401 | 9.91 951 | 8  | 11 |       |
| 50 | 9.74 568 | 19 | 9.82 626 | 28    | 0.17 374 | 9.91 942 | 8  | 10 |       |
| 51 | 9.74 587 | 19 | 9.82 653 | 27    | 0.17 347 | 9.91 934 | 8  | 9  |       |
| 52 | 9.74 606 | 19 | 9.82 681 | 28    | 0.17 319 | 9.91 925 | 8  | 8  |       |
| 53 | 9.74 625 | 19 | 9.82 708 | 27    | 0.17 292 | 9.91 917 | 8  | 7  |       |
| 54 | 9.74 644 | 18 | 9.82 735 | 28    | 0.17 265 | 9.91 908 | 8  | 6  |       |
| 55 | 9.74 662 | 19 | 9.82 762 | 27    | 0.17 238 | 9.91 900 | 8  | 5  |       |
| 56 | 9.74 681 | 19 | 9.82 790 | 28    | 0.17 210 | 9.91 891 | 8  | 4  |       |
| 57 | 9.74 700 | 19 | 9.82 817 | 27    | 0.17 183 | 9.91 883 | 8  | 3  |       |
| 58 | 9.74 719 | 19 | 9.82 844 | 28    | 0.17 156 | 9.91 874 | 8  | 2  |       |
| 59 | 9.74 737 | 18 | 9.82 871 | 27    | 0.17 129 | 9.91 866 | 8  | 1  |       |
| 60 | 9.74 756 | 19 | 9.82 899 | 28    | 0.17 101 | 9.91 857 | 8  | 0  |       |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Sin.  | d.       |    |    | P. P. |

28 27  
1 2.8 2.7  
2 5.6 5.4  
3 8.4 8.1  
4 11.2 10.8  
5 14.0 13.5  
6 16.8 16.2  
7 19.6 18.9  
8 22.4 21.6  
9 25.2 24.3

20 19 18  
1 2.0 1.9 1.8  
2 4.0 3.8 3.6  
3 6.0 5.7 5.4  
4 8.0 7.6 7.2  
5 10.0 9.5 9.0  
6 12.0 11.4 10.8  
7 14.0 13.3 12.6  
8 16.0 15.2 14.4  
9 18.0 17.1 16.2

9 8  
1 0.9 0.8  
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4 3.6 3.2  
5 4.5 4.0  
6 5.4 4.8  
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9 9 8  
28 27 27  
0 1.6 1.5 1.7  
1 4.7 4.5 5.1  
2 7.8 7.5 8.4  
3 10.9 10.5 11.8  
4 14.0 13.5 15.2  
5 17.1 16.5 18.6  
6 20.2 19.5 21.9  
7 23.3 22.5 25.3  
8 26.4 25.5 —  
9

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.            |
|----|----------|----|----------|-------|----------|----------|----|----|------------------|
| 0  | 9.74 756 | 19 | 9.82 899 | 27    | 0.17 101 | 9.91 857 | 8  | 60 |                  |
| 1  | 9.74 775 | 19 | 9.82 926 | 27    | 0.17 074 | 9.91 849 | 9  | 59 |                  |
| 2  | 9.74 794 | 18 | 9.82 953 | 27    | 0.17 047 | 9.91 840 | 9  | 58 |                  |
| 3  | 9.74 812 | 19 | 9.82 980 | 28    | 0.17 020 | 9.91 832 | 8  | 57 |                  |
| 4  | 9.74 831 | 19 | 9.83 008 | 27    | 0.16 992 | 9.91 823 | 8  | 56 | 28 27 26         |
| 5  | 9.74 850 | 18 | 9.83 035 | 27    | 0.16 965 | 9.91 815 | 9  | 55 | 1 2.8 2.7 2.6    |
| 6  | 9.74 868 | 19 | 9.83 062 | 27    | 0.16 938 | 9.91 806 | 9  | 54 | 2 5.6 5.4 5.2    |
| 7  | 9.74 887 | 19 | 9.83 089 | 27    | 0.16 911 | 9.91 798 | 8  | 53 | 3 8.4 8.1 7.8    |
| 8  | 9.74 906 | 18 | 9.83 117 | 28    | 0.16 883 | 9.91 789 | 9  | 52 | 4 11.2 10.8 10.4 |
| 9  | 9.74 924 | 19 | 9.83 144 | 27    | 0.16 856 | 9.91 781 | 8  | 51 | 5 14.0 13.5 13.0 |
| 10 | 9.74 943 | 18 | 9.83 171 | 27    | 0.16 829 | 9.91 772 | 9  | 50 | 6 16.8 16.2 15.6 |
| 11 | 9.74 961 | 19 | 9.83 198 | 27    | 0.16 802 | 9.91 763 | 8  | 49 | 7 19.6 18.9 18.2 |
| 12 | 9.74 980 | 19 | 9.83 225 | 27    | 0.16 775 | 9.91 755 | 8  | 48 | 8 22.4 21.6 20.8 |
| 13 | 9.74 999 | 18 | 9.83 252 | 28    | 0.16 748 | 9.91 746 | 8  | 47 | 9 25.2 24.3 23.4 |
| 14 | 9.75 017 | 19 | 9.83 280 | 27    | 0.16 720 | 9.91 738 | 9  | 46 |                  |
| 15 | 9.75 036 | 18 | 9.83 307 | 27    | 0.16 693 | 9.91 729 | 9  | 45 |                  |
| 16 | 9.75 054 | 19 | 9.83 334 | 27    | 0.16 666 | 9.91 720 | 8  | 44 |                  |
| 17 | 9.75 073 | 19 | 9.83 361 | 27    | 0.16 639 | 9.91 712 | 9  | 43 | 19 18            |
| 18 | 9.75 091 | 18 | 9.83 388 | 27    | 0.16 612 | 9.91 703 | 8  | 42 | 1 1.9 1.8        |
| 19 | 9.75 110 | 19 | 9.83 415 | 27    | 0.16 585 | 9.91 695 | 8  | 41 | 2 3.8 3.6        |
| 20 | 9.75 128 | 18 | 9.83 442 | 28    | 0.16 558 | 9.91 686 | 9  | 40 | 3 5.7 5.4        |
| 21 | 9.75 147 | 19 | 9.83 470 | 27    | 0.16 530 | 9.91 677 | 8  | 39 | 4 7.6 7.2        |
| 22 | 9.75 165 | 19 | 9.83 497 | 27    | 0.16 503 | 9.91 669 | 9  | 38 | 5 9.5 9.0        |
| 23 | 9.75 184 | 18 | 9.83 524 | 27    | 0.16 476 | 9.91 660 | 9  | 37 | 6 11.4 10.8      |
| 24 | 9.75 202 | 19 | 9.83 551 | 27    | 0.16 449 | 9.91 651 | 8  | 36 | 7 13.3 12.6      |
| 25 | 9.75 221 | 18 | 9.83 578 | 27    | 0.16 422 | 9.91 643 | 9  | 35 | 8 15.2 14.4      |
| 26 | 9.75 239 | 19 | 9.83 605 | 27    | 0.16 395 | 9.91 634 | 9  | 34 | 9 17.1 16.2      |
| 27 | 9.75 258 | 18 | 9.83 632 | 27    | 0.16 368 | 9.91 625 | 8  | 33 |                  |
| 28 | 9.75 276 | 18 | 9.83 659 | 27    | 0.16 341 | 9.91 617 | 8  | 32 |                  |
| 29 | 9.75 294 | 19 | 9.83 686 | 27    | 0.16 314 | 9.91 608 | 9  | 31 |                  |
| 30 | 9.75 313 | 18 | 9.83 713 | 27    | 0.16 287 | 9.91 599 | 8  | 30 | 9 8              |
| 31 | 9.75 331 | 19 | 9.83 740 | 28    | 0.16 260 | 9.91 591 | 9  | 29 | 1 0.9 0.8        |
| 32 | 9.75 350 | 18 | 9.83 768 | 27    | 0.16 232 | 9.91 582 | 9  | 28 | 2 1.8 1.6        |
| 33 | 9.75 368 | 18 | 9.83 795 | 27    | 0.16 205 | 9.91 573 | 8  | 27 | 3 2.7 2.4        |
| 34 | 9.75 386 | 19 | 9.83 822 | 27    | 0.16 178 | 9.91 565 | 9  | 26 | 4 3.6 3.2        |
| 35 | 9.75 405 | 18 | 9.83 849 | 27    | 0.16 151 | 9.91 556 | 9  | 25 | 5 4.5 4.0        |
| 36 | 9.75 423 | 18 | 9.83 876 | 27    | 0.16 124 | 9.91 547 | 9  | 24 | 6 5.4 4.8        |
| 37 | 9.75 441 | 18 | 9.83 903 | 27    | 0.16 097 | 9.91 538 | 8  | 23 | 7 6.3 5.6        |
| 38 | 9.75 459 | 19 | 9.83 930 | 27    | 0.16 070 | 9.91 530 | 9  | 22 | 8 7.2 6.4        |
| 39 | 9.75 478 | 18 | 9.83 957 | 27    | 0.16 043 | 9.91 521 | 9  | 21 | 9 8.1 7.2        |
| 40 | 9.75 496 | 18 | 9.83 984 | 27    | 0.16 016 | 9.91 512 | 8  | 20 |                  |
| 41 | 9.75 514 | 19 | 9.84 011 | 27    | 0.15 989 | 9.91 504 | 9  | 19 |                  |
| 42 | 9.75 533 | 18 | 9.84 038 | 27    | 0.15 962 | 9.91 495 | 9  | 18 |                  |
| 43 | 9.75 551 | 18 | 9.84 065 | 27    | 0.15 935 | 9.91 486 | 9  | 17 |                  |
| 44 | 9.75 569 | 18 | 9.84 092 | 27    | 0.15 908 | 9.91 477 | 8  | 16 |                  |
| 45 | 9.75 587 | 18 | 9.84 119 | 27    | 0.15 881 | 9.91 469 | 8  | 15 |                  |
| 46 | 9.75 605 | 19 | 9.84 146 | 27    | 0.15 854 | 9.91 460 | 9  | 14 |                  |
| 47 | 9.75 624 | 18 | 9.84 173 | 27    | 0.15 827 | 9.91 451 | 9  | 13 | 9 8 8            |
| 48 | 9.75 642 | 18 | 9.84 200 | 27    | 0.15 800 | 9.91 442 | 9  | 12 | 28 28 27         |
| 49 | 9.75 660 | 18 | 9.84 227 | 27    | 0.15 773 | 9.91 433 | 9  | 11 |                  |
| 50 | 9.75 678 | 18 | 9.84 254 | 26    | 0.15 746 | 9.91 425 | 8  | 10 |                  |
| 51 | 9.75 696 | 18 | 9.84 280 | 27    | 0.15 720 | 9.91 416 | 9  | 9  | 1 1.6 1.5 1.7    |
| 52 | 9.75 714 | 19 | 9.84 307 | 27    | 0.15 693 | 9.91 407 | 9  | 8  | 2 4.7 5.2 5.1    |
| 53 | 9.75 733 | 18 | 9.84 334 | 27    | 0.15 666 | 9.91 398 | 9  | 7  | 3 7.8 8.8 8.4    |
| 54 | 9.75 751 | 18 | 9.84 361 | 27    | 0.15 639 | 9.91 389 | 9  | 6  | 4 10.9 12.2 11.8 |
| 55 | 9.75 769 | 18 | 9.84 388 | 27    | 0.15 612 | 9.91 381 | 8  | 5  | 5 14.0 15.8 15.2 |
| 56 | 9.75 787 | 18 | 9.84 415 | 27    | 0.15 585 | 9.91 372 | 9  | 4  | 6 17.1 19.2 18.6 |
| 57 | 9.75 805 | 18 | 9.84 442 | 27    | 0.15 558 | 9.91 363 | 9  | 3  | 7 20.2 22.8 21.9 |
| 58 | 9.75 823 | 18 | 9.84 469 | 27    | 0.15 531 | 9.91 354 | 9  | 2  | 8 23.3 26.2 25.3 |
| 59 | 9.75 841 | 18 | 9.84 496 | 27    | 0.15 504 | 9.91 345 | 9  | 1  | 9 26.4 — —       |
| 60 | 9.75 859 | 18 | 9.84 523 | 27    | 0.15 477 | 9.91 336 | 9  | 0  |                  |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P.            |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.         |
|----|----------|----|----------|-------|----------|----------|----|----|---------------|
| 0  | 9.75 859 | 18 | 9.84 523 | 27    | 0.15 477 | 9.91 336 | 8  | 60 |               |
| 1  | 9.75 877 | 18 | 9.84 530 | 26    | 0.15 450 | 9.91 328 | 9  | 59 | 27 26         |
| 2  | 9.75 895 | 18 | 9.84 576 | 27    | 0.15 424 | 9.91 319 | 9  | 58 | 1 2.7 2.6     |
| 3  | 9.75 913 | 18 | 9.84 603 | 27    | 0.15 397 | 9.91 310 | 9  | 57 | 2 5.4 5.2     |
| 4  | 9.75 931 | 18 | 9.84 630 | 27    | 0.15 370 | 9.91 301 | 9  | 56 | 3 8.1 7.8     |
| 5  | 9.75 949 | 18 | 9.84 657 | 27    | 0.15 343 | 9.91 292 | 9  | 55 | 4 10.8 10.4   |
| 6  | 9.75 967 | 18 | 9.84 684 | 27    | 0.15 316 | 9.91 283 | 9  | 54 | 5 13.5 13.0   |
| 7  | 9.75 985 | 18 | 9.84 711 | 27    | 0.15 289 | 9.91 274 | 8  | 53 | 6 16.2 15.6   |
| 8  | 9.75 003 | 18 | 9.84 738 | 27    | 0.15 262 | 9.91 266 | 8  | 52 | 7 18.9 18.2   |
| 9  | 9.76 021 | 18 | 9.84 764 | 26    | 0.15 236 | 9.91 257 | 9  | 51 | 8 21.6 20.8   |
| 10 | 9.76 039 | 18 | 9.84 791 | 27    | 0.15 209 | 9.91 248 | 9  | 50 | 9 24.3 23.4   |
| 11 | 9.76 057 | 18 | 9.84 818 | 27    | 0.15 182 | 9.91 239 | 9  | 49 |               |
| 12 | 9.76 075 | 18 | 9.84 845 | 27    | 0.15 155 | 9.91 230 | 9  | 48 | 18 17         |
| 13 | 9.76 093 | 18 | 9.84 872 | 27    | 0.15 128 | 9.91 221 | 9  | 47 | 1 1.8 1.7     |
| 14 | 9.76 111 | 18 | 9.84 899 | 27    | 0.15 101 | 9.91 212 | 9  | 46 | 2 3.6 3.4     |
| 15 | 9.76 129 | 17 | 9.84 925 | 26    | 0.15 075 | 9.91 203 | 9  | 45 | 3 5.4 5.1     |
| 16 | 9.76 146 | 17 | 9.84 952 | 27    | 0.15 048 | 9.91 194 | 9  | 44 | 4 7.2 6.8     |
| 17 | 9.76 164 | 18 | 9.84 979 | 27    | 0.15 021 | 9.91 185 | 9  | 43 | 5 9.0 8.5     |
| 18 | 9.76 182 | 18 | 9.85 006 | 27    | 0.14 994 | 9.91 176 | 9  | 42 | 6 10.8 10.2   |
| 19 | 9.76 200 | 18 | 9.85 033 | 26    | 0.14 967 | 9.91 167 | 9  | 41 | 7 12.6 11.9   |
| 20 | 9.76 218 | 18 | 9.85 059 | 27    | 0.14 941 | 9.91 158 | 9  | 40 | 8 14.4 13.6   |
| 21 | 9.76 236 | 17 | 9.85 086 | 27    | 0.14 914 | 9.91 149 | 8  | 39 | 9 16.2 15.3   |
| 22 | 9.76 253 | 18 | 9.85 113 | 27    | 0.14 887 | 9.91 141 | 8  | 38 |               |
| 23 | 9.76 271 | 18 | 9.85 140 | 26    | 0.14 860 | 9.91 132 | 9  | 37 | 10 9 8        |
| 24 | 9.76 289 | 18 | 9.85 166 | 26    | 0.14 834 | 9.91 123 | 9  | 36 | 1 1.0 0.9 0.8 |
| 25 | 9.76 307 | 17 | 9.85 193 | 27    | 0.14 807 | 9.91 114 | 9  | 35 | 2 2.0 1.8 1.6 |
| 26 | 9.76 324 | 17 | 9.85 220 | 27    | 0.14 780 | 9.91 105 | 9  | 34 | 3 3.0 2.7 2.4 |
| 27 | 9.76 342 | 18 | 9.85 247 | 26    | 0.14 753 | 9.91 096 | 9  | 33 | 4 4.0 3.6 3.2 |
| 28 | 9.76 360 | 18 | 9.85 273 | 27    | 0.14 727 | 9.91 087 | 9  | 32 | 5 5.0 4.5 4.0 |
| 29 | 9.76 378 | 17 | 9.85 300 | 27    | 0.14 700 | 9.91 078 | 9  | 31 | 6 6.0 5.4 4.8 |
| 30 | 9.76 395 | 18 | 9.85 327 | 27    | 0.14 673 | 9.91 069 | 9  | 30 | 7 7.0 6.3 5.6 |
| 31 | 9.76 413 | 18 | 9.85 354 | 26    | 0.14 646 | 9.91 060 | 9  | 29 | 8 8.0 7.2 6.4 |
| 32 | 9.76 431 | 17 | 9.85 380 | 27    | 0.14 620 | 9.91 051 | 9  | 28 | 9 9.0 8.1 7.2 |
| 33 | 9.76 448 | 18 | 9.85 407 | 27    | 0.14 593 | 9.91 042 | 9  | 27 |               |
| 34 | 9.76 466 | 18 | 9.85 434 | 26    | 0.14 566 | 9.91 033 | 10 | 26 |               |
| 35 | 9.76 484 | 17 | 9.85 460 | 27    | 0.14 540 | 9.91 023 | 9  | 25 | 10 10         |
| 36 | 9.76 501 | 17 | 9.85 487 | 27    | 0.14 513 | 9.91 014 | 9  | 24 | 27 26         |
| 37 | 9.76 519 | 18 | 9.85 514 | 26    | 0.14 486 | 9.91 005 | 9  | 23 |               |
| 38 | 9.76 537 | 17 | 9.85 540 | 27    | 0.14 460 | 9.90 996 | 9  | 22 | 0 1.4 1.3     |
| 39 | 9.76 554 | 17 | 9.85 567 | 27    | 0.14 433 | 9.90 987 | 9  | 21 | 1 4.0 3.9     |
| 40 | 9.76 572 | 18 | 9.85 594 | 26    | 0.14 406 | 9.90 978 | 9  | 20 | 2 6.8 6.5     |
| 41 | 9.76 590 | 17 | 9.85 620 | 27    | 0.14 380 | 9.90 969 | 9  | 19 | 3 9.4 9.1     |
| 42 | 9.76 607 | 18 | 9.85 647 | 27    | 0.14 353 | 9.90 960 | 9  | 18 | 4 12.2 11.7   |
| 43 | 9.76 625 | 17 | 9.85 674 | 26    | 0.14 326 | 9.90 951 | 9  | 17 | 5 14.8 14.3   |
| 44 | 9.76 642 | 17 | 9.85 700 | 27    | 0.14 300 | 9.90 942 | 9  | 16 | 6 17.6 16.9   |
| 45 | 9.76 660 | 17 | 9.85 727 | 27    | 0.14 273 | 9.90 933 | 9  | 15 | 7 20.2 19.5   |
| 46 | 9.76 677 | 18 | 9.85 754 | 26    | 0.14 246 | 9.90 924 | 9  | 14 | 8 23.0 22.1   |
| 47 | 9.76 695 | 17 | 9.85 780 | 27    | 0.14 220 | 9.90 915 | 9  | 13 | 9 25.6 24.7   |
| 48 | 9.76 712 | 17 | 9.85 807 | 27    | 0.14 193 | 9.90 906 | 9  | 12 |               |
| 49 | 9.76 730 | 17 | 9.85 834 | 26    | 0.14 166 | 9.90 896 | 10 | 11 | 9 9           |
| 50 | 9.76 747 | 18 | 9.85 860 | 27    | 0.14 140 | 9.90 887 | 9  | 10 | 27 26         |
| 51 | 9.76 765 | 17 | 9.85 887 | 26    | 0.14 113 | 9.90 878 | 9  | 9  |               |
| 52 | 9.76 782 | 18 | 9.85 913 | 27    | 0.14 087 | 9.90 869 | 9  | 8  | 0 1.5 1.4     |
| 53 | 9.76 800 | 17 | 9.85 940 | 27    | 0.14 060 | 9.90 860 | 9  | 7  | 1 4.5 4.3     |
| 54 | 9.76 817 | 17 | 9.85 967 | 26    | 0.14 033 | 9.90 851 | 9  | 6  | 2 7.5 7.2     |
| 55 | 9.76 835 | 17 | 9.85 993 | 27    | 0.14 007 | 9.90 842 | 9  | 5  | 3 10.5 10.1   |
| 56 | 9.76 852 | 18 | 9.86 020 | 26    | 0.13 980 | 9.90 832 | 10 | 4  | 4 13.5 13.0   |
| 57 | 9.76 870 | 17 | 9.86 046 | 27    | 0.13 954 | 9.90 823 | 9  | 3  | 5 16.5 15.9   |
| 58 | 9.76 887 | 17 | 9.86 073 | 27    | 0.13 927 | 9.90 814 | 9  | 2  | 6 19.5 18.8   |
| 59 | 9.76 904 | 18 | 9.86 100 | 26    | 0.13 900 | 9.90 805 | 9  | 1  | 7 22.5 21.7   |
| 60 | 9.76 922 |    | 9.86 126 |       | 0.13 874 | 9.90 796 | 9  | 0  | 8 25.5 24.6   |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Sin.  | d.       |    |    | P. P.         |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.            |
|----|----------|----|----------|-------|----------|----------|----|----|------------------|
| 0  | 9.76 922 | 17 | 9.86 126 | 27    | 0.13 874 | 9.90 796 | 9  | 60 |                  |
| 1  | 9.76 939 | 18 | 9.86 153 | 26    | 0.13 847 | 9.90 787 | 10 | 59 |                  |
| 2  | 9.76 957 | 17 | 9.86 179 | 27    | 0.13 821 | 9.90 777 | 9  | 58 |                  |
| 3  | 9.76 974 | 17 | 9.86 206 | 26    | 0.13 794 | 9.90 768 | 9  | 57 |                  |
| 4  | 9.76 991 | 18 | 9.86 232 | 26    | 0.13 768 | 9.90 759 | 9  | 56 | 27 26            |
| 5  | 9.77 009 | 17 | 9.86 259 | 27    | 0.13 741 | 9.90 750 | 9  | 55 | 1 2.7 2.6        |
| 6  | 9.77 026 | 17 | 9.86 285 | 26    | 0.13 715 | 9.90 741 | 10 | 54 | 2 5.4 5.2        |
| 7  | 9.77 043 | 18 | 9.86 312 | 27    | 0.13 688 | 9.90 731 | 9  | 53 | 3 8.1 7.8        |
| 8  | 9.77 061 | 17 | 9.86 338 | 26    | 0.13 662 | 9.90 722 | 9  | 52 | 4 10.8 10.4      |
| 9  | 9.77 078 | 17 | 9.86 365 | 27    | 0.13 635 | 9.90 713 | 9  | 51 | 5 13.5 13.0      |
| 10 | 9.77 095 | 17 | 9.86 392 | 26    | 0.13 608 | 9.90 704 | 10 | 50 | 6 16.2 15.6      |
| 11 | 9.77 112 | 18 | 9.86 418 | 27    | 0.13 582 | 9.90 694 | 9  | 49 | 7 18.9 18.2      |
| 12 | 9.77 130 | 17 | 9.86 445 | 26    | 0.13 555 | 9.90 685 | 9  | 48 | 8 21.6 20.8      |
| 13 | 9.77 147 | 17 | 9.86 471 | 26    | 0.13 529 | 9.90 676 | 9  | 47 | 9 24.3 23.4      |
| 14 | 9.77 164 | 17 | 9.86 498 | 26    | 0.13 502 | 9.90 667 | 10 | 46 |                  |
| 15 | 9.77 181 | 18 | 9.86 524 | 27    | 0.13 476 | 9.90 657 | 9  | 45 |                  |
| 16 | 9.77 199 | 17 | 9.86 551 | 26    | 0.13 449 | 9.90 648 | 9  | 44 |                  |
| 17 | 9.77 216 | 17 | 9.86 577 | 26    | 0.13 423 | 9.90 639 | 9  | 43 | 18 17 16         |
| 18 | 9.77 233 | 17 | 9.86 603 | 27    | 0.13 397 | 9.90 630 | 10 | 42 | 1 1.8 1.7 1.6    |
| 19 | 9.77 250 | 18 | 9.86 630 | 26    | 0.13 370 | 9.90 620 | 9  | 41 | 2 3.6 3.4 3.2    |
| 20 | 9.77 268 | 17 | 9.86 656 | 27    | 0.13 344 | 9.90 611 | 9  | 40 | 3 5.4 5.1 4.8    |
| 21 | 9.77 285 | 17 | 9.86 683 | 26    | 0.13 317 | 9.90 602 | 10 | 39 | 4 7.2 6.8 6.4    |
| 22 | 9.77 302 | 17 | 9.86 709 | 27    | 0.13 291 | 9.90 592 | 9  | 38 | 5 9.0 8.5 8.0    |
| 23 | 9.77 319 | 17 | 9.86 736 | 26    | 0.13 264 | 9.90 583 | 9  | 37 | 6 10.8 10.2 9.6  |
| 24 | 9.77 336 | 17 | 9.86 762 | 27    | 0.13 238 | 9.90 574 | 9  | 36 | 7 12.6 11.9 11.2 |
| 25 | 9.77 353 | 17 | 9.86 789 | 26    | 0.13 211 | 9.90 565 | 10 | 35 | 8 14.4 13.6 12.8 |
| 26 | 9.77 370 | 17 | 9.86 815 | 26    | 0.13 185 | 9.90 555 | 9  | 34 | 9 16.2 15.3 14.4 |
| 27 | 9.77 387 | 18 | 9.86 842 | 27    | 0.13 158 | 9.90 546 | 9  | 33 |                  |
| 28 | 9.77 405 | 17 | 9.86 868 | 26    | 0.13 132 | 9.90 537 | 10 | 32 |                  |
| 29 | 9.77 422 | 17 | 9.86 894 | 26    | 0.13 106 | 9.90 527 | 9  | 31 |                  |
| 30 | 9.77 439 | 17 | 9.86 921 | 26    | 0.13 079 | 9.90 518 | 9  | 30 | 10 9             |
| 31 | 9.77 456 | 17 | 9.86 947 | 27    | 0.13 053 | 9.90 509 | 10 | 29 | 1 1.0 0.9        |
| 32 | 9.77 473 | 17 | 9.86 974 | 26    | 0.13 026 | 9.90 499 | 9  | 28 | 2 2.0 1.8        |
| 33 | 9.77 490 | 17 | 9.87 000 | 26    | 0.13 000 | 9.90 490 | 10 | 27 | 3 3.0 2.7        |
| 34 | 9.77 507 | 17 | 9.87 027 | 26    | 0.12 973 | 9.90 480 | 9  | 26 | 4 4.0 3.6        |
| 35 | 9.77 524 | 17 | 9.87 053 | 27    | 0.12 947 | 9.90 471 | 9  | 25 | 5 5.0 4.5        |
| 36 | 9.77 541 | 17 | 9.87 079 | 26    | 0.12 921 | 9.90 462 | 10 | 24 | 6 6.0 5.4        |
| 37 | 9.77 558 | 17 | 9.87 106 | 26    | 0.12 894 | 9.90 452 | 9  | 23 | 7 7.0 6.3        |
| 38 | 9.77 575 | 17 | 9.87 132 | 26    | 0.12 868 | 9.90 443 | 9  | 22 | 8 8.0 7.2        |
| 39 | 9.77 592 | 17 | 9.87 158 | 26    | 0.12 842 | 9.90 434 | 10 | 21 | 9 9.0 8.1        |
| 40 | 9.77 609 | 17 | 9.87 185 | 27    | 0.12 815 | 9.90 424 | 9  | 20 |                  |
| 41 | 9.77 626 | 17 | 9.87 211 | 26    | 0.12 789 | 9.90 415 | 9  | 19 |                  |
| 42 | 9.77 643 | 17 | 9.87 238 | 27    | 0.12 762 | 9.90 405 | 9  | 18 |                  |
| 43 | 9.77 660 | 17 | 9.87 264 | 26    | 0.12 736 | 9.90 396 | 10 | 17 |                  |
| 44 | 9.77 677 | 17 | 9.87 290 | 26    | 0.12 710 | 9.90 386 | 9  | 16 |                  |
| 45 | 9.77 694 | 17 | 9.87 317 | 26    | 0.12 683 | 9.90 377 | 9  | 15 |                  |
| 46 | 9.77 711 | 17 | 9.87 343 | 26    | 0.12 657 | 9.90 368 | 10 | 14 |                  |
| 47 | 9.77 728 | 16 | 9.87 369 | 26    | 0.12 631 | 9.90 358 | 9  | 13 | 9 9              |
| 48 | 9.77 744 | 17 | 9.87 396 | 26    | 0.12 604 | 9.90 349 | 9  | 12 | 27 26            |
| 49 | 9.77 761 | 17 | 9.87 422 | 26    | 0.12 578 | 9.90 339 | 10 | 11 | 0 1.5 1.4        |
| 50 | 9.77 778 | 17 | 9.87 448 | 27    | 0.12 552 | 9.90 330 | 9  | 10 | 1 4.5 4.3        |
| 51 | 9.77 795 | 17 | 9.87 475 | 26    | 0.12 525 | 9.90 320 | 10 | 9  | 2 7.5 7.2        |
| 52 | 9.77 812 | 17 | 9.87 501 | 26    | 0.12 499 | 9.90 311 | 9  | 8  | 3 10.5 10.1      |
| 53 | 9.77 829 | 17 | 9.87 527 | 27    | 0.12 473 | 9.90 301 | 10 | 7  | 4 13.5 13.0      |
| 54 | 9.77 846 | 16 | 9.87 554 | 26    | 0.12 446 | 9.90 292 | 9  | 6  | 5 16.5 15.9      |
| 55 | 9.77 862 | 17 | 9.87 580 | 26    | 0.12 420 | 9.90 282 | 10 | 5  | 6 19.5 18.8      |
| 56 | 9.77 879 | 17 | 9.87 606 | 26    | 0.12 394 | 9.90 273 | 9  | 4  | 7 22.5 21.7      |
| 57 | 9.77 896 | 17 | 9.87 633 | 26    | 0.12 367 | 9.90 263 | 10 | 3  | 8 25.5 24.6      |
| 58 | 9.77 913 | 17 | 9.87 659 | 26    | 0.12 341 | 9.90 254 | 9  | 2  |                  |
| 59 | 9.77 930 | 16 | 9.87 685 | 26    | 0.12 315 | 9.90 244 | 10 | 1  |                  |
| 60 | 9.77 946 |    | 9.87 711 |       | 0.12 289 | 9.90 235 | 9  | 0  |                  |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P.            |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.       |
|----|----------|----|----------|-------|----------|----------|----|----|-------------|
| 0  | 9.77 946 | 17 | 9.87 711 | 27    | 0.12 289 | 9.90 235 | 10 | 60 |             |
| 1  | 9.77 963 | 17 | 9.87 738 | 26    | 0.12 262 | 9.90 225 | 9  | 59 |             |
| 2  | 9.77 980 | 17 | 9.87 764 | 26    | 0.12 236 | 9.90 216 | 10 | 58 |             |
| 3  | 9.77 997 | 16 | 9.87 790 | 27    | 0.12 210 | 9.90 206 | 10 | 57 |             |
| 4  | 9.78 013 | 17 | 9.87 817 | 26    | 0.12 183 | 9.90 197 | 10 | 56 | 27 26       |
| 5  | 9.78 030 | 17 | 9.87 843 | 26    | 0.12 157 | 9.90 187 | 9  | 55 | 1 2.7 2.6   |
| 6  | 9.78 047 | 16 | 9.87 869 | 26    | 0.12 131 | 9.90 178 | 9  | 54 | 2 5.4 5.2   |
| 7  | 9.78 063 | 17 | 9.87 895 | 27    | 0.12 105 | 9.90 168 | 9  | 53 | 3 8. 7.8    |
| 8  | 9.78 080 | 17 | 9.87 922 | 26    | 0.12 078 | 9.90 159 | 10 | 52 | 4 10.8 10.4 |
| 9  | 9.78 097 | 16 | 9.87 948 | 26    | 0.12 052 | 9.90 149 | 10 | 51 | 5 13.5 13.0 |
| 10 | 9.78 113 | 17 | 9.87 974 | 26    | 0.12 026 | 9.90 139 | 9  | 50 | 6 16.2 15.6 |
| 11 | 9.78 130 | 17 | 9.88 000 | 27    | 0.12 000 | 9.90 130 | 9  | 49 | 7 18.9 18.2 |
| 12 | 9.78 147 | 16 | 9.88 027 | 26    | 0.11 973 | 9.90 120 | 9  | 48 | 8 21.6 20.8 |
| 13 | 9.78 163 | 17 | 9.88 053 | 26    | 0.11 947 | 9.90 111 | 9  | 47 | 9 24.3 23.4 |
| 14 | 9.78 180 | 17 | 9.88 079 | 26    | 0.11 921 | 9.90 101 | 10 | 46 |             |
| 15 | 9.78 197 | 17 | 9.88 105 | 26    | 0.11 895 | 9.90 091 | 9  | 45 |             |
| 16 | 9.78 213 | 16 | 9.88 131 | 27    | 0.11 869 | 9.90 082 | 10 | 44 |             |
| 17 | 9.78 230 | 16 | 9.88 158 | 26    | 0.11 842 | 9.90 072 | 9  | 43 | 17 16       |
| 18 | 9.78 246 | 16 | 9.88 184 | 26    | 0.11 816 | 9.90 063 | 9  | 42 | 1 1.7 1.6   |
| 19 | 9.78 263 | 17 | 9.88 210 | 26    | 0.11 790 | 9.90 053 | 10 | 41 | 2 3.4 3.2   |
| 20 | 9.78 280 | 16 | 9.88 236 | 26    | 0.11 764 | 9.90 043 | 9  | 40 | 3 5.1 4.8   |
| 21 | 9.78 296 | 17 | 9.88 262 | 27    | 0.11 738 | 9.90 034 | 10 | 39 | 4 6.8 6.4   |
| 22 | 9.78 313 | 16 | 9.88 289 | 26    | 0.11 711 | 9.90 024 | 10 | 38 | 5 8.5 8.0   |
| 23 | 9.78 329 | 17 | 9.88 315 | 26    | 0.11 685 | 9.90 014 | 10 | 37 | 6 10.2 9.6  |
| 24 | 9.78 346 | 16 | 9.88 341 | 26    | 0.11 659 | 9.90 005 | 9  | 36 | 7 11.9 11.2 |
| 25 | 9.78 362 | 17 | 9.88 367 | 26    | 0.11 633 | 9.89 995 | 10 | 35 | 8 13.6 12.8 |
| 26 | 9.78 379 | 16 | 9.88 393 | 27    | 0.11 607 | 9.89 985 | 9  | 34 | 9 15.3 14.4 |
| 27 | 9.78 395 | 17 | 9.88 420 | 26    | 0.11 580 | 9.89 976 | 10 | 33 |             |
| 28 | 9.78 412 | 16 | 9.88 446 | 26    | 0.11 554 | 9.89 966 | 10 | 32 |             |
| 29 | 9.78 428 | 17 | 9.88 472 | 26    | 0.11 528 | 9.89 956 | 10 | 31 |             |
| 30 | 9.78 445 | 16 | 9.88 498 | 26    | 0.11 502 | 9.89 947 | 9  | 30 | 10 9        |
| 31 | 9.78 461 | 17 | 9.88 524 | 26    | 0.11 476 | 9.89 937 | 10 | 29 | 1 1.0 0.9   |
| 32 | 9.78 478 | 16 | 9.88 550 | 27    | 0.11 450 | 9.89 927 | 9  | 28 | 2 2.0 1.8   |
| 33 | 9.78 494 | 17 | 9.88 577 | 26    | 0.11 423 | 9.89 918 | 10 | 27 | 3 3.0 2.7   |
| 34 | 9.78 510 | 16 | 9.88 603 | 26    | 0.11 397 | 9.89 908 | 10 | 26 | 4 4.0 3.6   |
| 35 | 9.78 527 | 17 | 9.88 629 | 26    | 0.11 371 | 9.89 898 | 10 | 25 | 5 5.0 4.5   |
| 36 | 9.78 543 | 16 | 9.88 655 | 26    | 0.11 345 | 9.89 888 | 9  | 24 | 6 6.0 5.4   |
| 37 | 9.78 560 | 17 | 9.88 681 | 26    | 0.11 319 | 9.89 879 | 10 | 23 | 7 7.0 6.3   |
| 38 | 9.78 576 | 16 | 9.88 707 | 26    | 0.11 293 | 9.89 869 | 10 | 22 | 8 8.0 7.2   |
| 39 | 9.78 592 | 17 | 9.88 733 | 26    | 0.11 267 | 9.89 859 | 10 | 21 | 9 9.0 8.1   |
| 40 | 9.78 609 | 16 | 9.88 759 | 27    | 0.11 241 | 9.89 849 | 9  | 20 |             |
| 41 | 9.78 625 | 17 | 9.88 786 | 26    | 0.11 214 | 9.89 840 | 10 | 19 |             |
| 42 | 9.78 642 | 16 | 9.88 812 | 26    | 0.11 188 | 9.89 830 | 10 | 18 |             |
| 43 | 9.78 658 | 17 | 9.88 838 | 26    | 0.11 162 | 9.89 820 | 10 | 17 |             |
| 44 | 9.78 674 | 16 | 9.88 864 | 26    | 0.11 136 | 9.89 810 | 9  | 16 |             |
| 45 | 9.78 691 | 17 | 9.88 890 | 26    | 0.11 110 | 9.89 801 | 10 | 15 |             |
| 46 | 9.78 707 | 16 | 9.88 916 | 26    | 0.11 084 | 9.89 791 | 10 | 14 | 10 10       |
| 47 | 9.78 723 | 17 | 9.88 942 | 26    | 0.11 058 | 9.89 781 | 10 | 13 | 27 26       |
| 48 | 9.78 739 | 16 | 9.88 968 | 26    | 0.11 032 | 9.89 771 | 10 | 12 |             |
| 49 | 9.78 756 | 17 | 9.88 994 | 26    | 0.11 006 | 9.89 761 | 10 | 11 | 0 1.4 1.3   |
| 50 | 9.78 772 | 16 | 9.89 020 | 26    | 0.10 980 | 9.89 752 | 9  | 10 | 1 4.0 3.9   |
| 51 | 9.78 788 | 17 | 9.89 046 | 27    | 0.10 954 | 9.89 742 | 10 | 9  | 2 6.8 6.5   |
| 52 | 9.78 805 | 16 | 9.89 073 | 26    | 0.10 927 | 9.89 732 | 10 | 8  | 3 9.4 9.1   |
| 53 | 9.78 821 | 17 | 9.89 099 | 26    | 0.10 901 | 9.89 722 | 10 | 7  | 4 12.2 11.7 |
| 54 | 9.78 837 | 16 | 9.89 125 | 26    | 0.10 875 | 9.89 712 | 10 | 6  | 5 14.8 14.3 |
| 55 | 9.78 853 | 17 | 9.89 151 | 26    | 0.10 849 | 9.89 702 | 10 | 5  | 6 17.6 16.9 |
| 56 | 9.78 869 | 16 | 9.89 177 | 26    | 0.10 823 | 9.89 693 | 9  | 4  | 7 20.2 19.5 |
| 57 | 9.78 886 | 17 | 9.89 203 | 26    | 0.10 797 | 9.89 683 | 10 | 3  | 8 23.0 22.1 |
| 58 | 9.78 902 | 16 | 9.89 229 | 26    | 0.10 771 | 9.89 673 | 10 | 2  | 9 25.6 24.7 |
| 59 | 9.78 918 | 17 | 9.89 255 | 26    | 0.10 745 | 9.89 663 | 10 | 1  |             |
| 60 | 9.78 934 | 16 | 9.89 281 | 26    | 0.10 719 | 9.89 653 | 10 | 0  |             |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Sin.  | L. Cos.  | d. |    | P. P.       |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. | P. P. |
|----|----------|----|----------|-------|----------|----------|----|-------|
| 1  | 9.78 934 | 16 | 9.89 281 | 26    | 0.10 719 | 9.89 653 | 10 | 60    |
| 2  | 9.78 950 | 17 | 9.89 307 | 26    | 0.10 693 | 9.89 643 | 10 | 59    |
| 3  | 9.78 967 | 18 | 9.89 333 | 26    | 0.10 667 | 9.89 633 | 9  | 58    |
| 4  | 9.78 983 | 19 | 9.89 359 | 26    | 0.10 641 | 9.89 624 | 9  | 57    |
| 5  | 9.78 999 | 16 | 9.89 385 | 26    | 0.10 615 | 9.89 614 | 10 | 56    |
| 6  | 9.79 015 | 16 | 9.89 411 | 26    | 0.10 589 | 9.89 604 | 10 | 55    |
| 7  | 9.79 031 | 16 | 9.89 437 | 26    | 0.10 563 | 9.89 594 | 10 | 54    |
| 8  | 9.79 047 | 16 | 9.89 463 | 26    | 0.10 537 | 9.89 584 | 10 | 53    |
| 9  | 9.79 063 | 16 | 9.89 489 | 26    | 0.10 511 | 9.89 574 | 10 | 52    |
| 10 | 9.79 079 | 16 | 9.89 515 | 26    | 0.10 485 | 9.89 564 | 10 | 51    |
| 11 | 9.79 095 | 16 | 9.89 541 | 26    | 0.10 459 | 9.89 554 | 10 | 50    |
| 12 | 9.79 111 | 17 | 9.89 567 | 26    | 0.10 433 | 9.89 544 | 10 | 49    |
| 13 | 9.79 128 | 18 | 9.89 593 | 26    | 0.10 407 | 9.89 534 | 10 | 48    |
| 14 | 9.79 144 | 19 | 9.89 619 | 26    | 0.10 381 | 9.89 524 | 10 | 47    |
| 15 | 9.79 160 | 16 | 9.89 645 | 26    | 0.10 355 | 9.89 514 | 10 | 46    |
| 16 | 9.79 176 | 16 | 9.89 671 | 26    | 0.10 329 | 9.89 504 | 9  | 45    |
| 17 | 9.79 192 | 16 | 9.89 697 | 26    | 0.10 303 | 9.89 495 | 9  | 44    |
| 18 | 9.79 208 | 16 | 9.89 723 | 26    | 0.10 277 | 9.89 485 | 10 | 43    |
| 19 | 9.79 224 | 16 | 9.89 749 | 26    | 0.10 251 | 9.89 475 | 10 | 42    |
| 20 | 9.79 240 | 16 | 9.89 775 | 26    | 0.10 225 | 9.89 465 | 10 | 41    |
| 21 | 9.79 256 | 16 | 9.89 801 | 26    | 0.10 199 | 9.89 455 | 10 | 40    |
| 22 | 9.79 272 | 16 | 9.89 827 | 26    | 0.10 173 | 9.89 445 | 10 | 39    |
| 23 | 9.79 288 | 16 | 9.89 853 | 26    | 0.10 147 | 9.89 435 | 10 | 38    |
| 24 | 9.79 304 | 15 | 9.89 879 | 26    | 0.10 121 | 9.89 425 | 10 | 37    |
| 25 | 9.79 319 | 15 | 9.89 905 | 26    | 0.10 095 | 9.89 415 | 10 | 36    |
| 26 | 9.79 335 | 16 | 9.89 931 | 26    | 0.10 069 | 9.89 405 | 10 | 35    |
| 27 | 9.79 351 | 16 | 9.89 957 | 26    | 0.10 043 | 9.89 395 | 10 | 34    |
| 28 | 9.79 367 | 16 | 9.89 983 | 26    | 0.10 017 | 9.89 385 | 10 | 33    |
| 29 | 9.79 383 | 16 | 9.90 009 | 26    | 0.09 991 | 9.89 375 | 10 | 32    |
| 30 | 9.79 399 | 16 | 9.90 035 | 26    | 0.09 965 | 9.89 364 | 11 | 31    |
| 31 | 9.79 415 | 16 | 9.90 061 | 25    | 0.09 939 | 9.89 354 | 10 | 30    |
| 32 | 9.79 431 | 16 | 9.90 086 | 26    | 0.09 914 | 9.89 344 | 10 | 29    |
| 33 | 9.79 447 | 16 | 9.90 112 | 26    | 0.09 888 | 9.89 334 | 10 | 28    |
| 34 | 9.79 463 | 15 | 9.90 138 | 26    | 0.09 862 | 9.89 324 | 10 | 27    |
| 35 | 9.79 478 | 15 | 9.90 164 | 26    | 0.09 836 | 9.89 314 | 10 | 26    |
| 36 | 9.79 494 | 16 | 9.90 190 | 26    | 0.09 810 | 9.89 304 | 10 | 25    |
| 37 | 9.79 510 | 16 | 9.90 216 | 26    | 0.09 784 | 9.89 294 | 10 | 24    |
| 38 | 9.79 526 | 16 | 9.90 242 | 26    | 0.09 758 | 9.89 284 | 10 | 23    |
| 39 | 9.79 542 | 16 | 9.90 268 | 26    | 0.09 732 | 9.89 274 | 10 | 22    |
| 40 | 9.79 558 | 15 | 9.90 294 | 26    | 0.09 706 | 9.89 264 | 10 | 21    |
| 41 | 9.79 573 | 16 | 9.90 320 | 26    | 0.09 680 | 9.89 254 | 10 | 20    |
| 42 | 9.79 589 | 16 | 9.90 346 | 25    | 0.09 654 | 9.89 244 | 11 | 19    |
| 43 | 9.79 605 | 16 | 9.90 371 | 26    | 0.09 629 | 9.89 233 | 10 | 18    |
| 44 | 9.79 621 | 15 | 9.90 397 | 26    | 0.09 603 | 9.89 223 | 10 | 17    |
| 45 | 9.79 636 | 15 | 9.90 423 | 26    | 0.09 577 | 9.89 213 | 10 | 16    |
| 46 | 9.79 652 | 16 | 9.90 449 | 26    | 0.09 551 | 9.89 203 | 10 | 15    |
| 47 | 9.79 668 | 16 | 9.90 475 | 26    | 0.09 525 | 9.89 193 | 10 | 14    |
| 48 | 9.79 684 | 15 | 9.90 501 | 26    | 0.09 499 | 9.89 183 | 10 | 13    |
| 49 | 9.79 699 | 16 | 9.90 527 | 26    | 0.09 473 | 9.89 173 | 10 | 12    |
| 50 | 9.79 715 | 16 | 9.90 553 | 25    | 0.09 447 | 9.89 162 | 11 | 11    |
| 51 | 9.79 731 | 15 | 9.90 578 | 26    | 0.09 422 | 9.89 152 | 10 | 10    |
| 52 | 9.79 746 | 16 | 9.90 604 | 26    | 0.09 396 | 9.89 142 | 10 | 9     |
| 53 | 9.79 762 | 16 | 9.90 630 | 26    | 0.09 370 | 9.89 132 | 10 | 8     |
| 54 | 9.79 778 | 15 | 9.90 656 | 26    | 0.09 344 | 9.89 122 | 10 | 7     |
| 55 | 9.79 793 | 15 | 9.90 682 | 26    | 0.09 318 | 9.89 112 | 10 | 6     |
| 56 | 9.79 809 | 16 | 9.90 708 | 26    | 0.09 292 | 9.89 101 | 11 | 5     |
| 57 | 9.79 825 | 15 | 9.90 734 | 25    | 0.09 266 | 9.89 091 | 10 | 4     |
| 58 | 9.79 840 | 16 | 9.90 759 | 26    | 0.09 241 | 9.89 081 | 10 | 3     |
| 59 | 9.79 856 | 16 | 9.90 785 | 26    | 0.09 215 | 9.89 071 | 10 | 2     |
| 60 | 9.79 872 | 15 | 9.90 811 | 26    | 0.09 189 | 9.89 060 | 11 | 1     |
|    | 9.79 887 |    | 9.90 837 |       | 0.09 163 | 9.89 050 | 10 | 0     |
|    | L. Cos.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Sin.  | d. | P. P. |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P. |
|----|----------|----|----------|-------|----------|----------|----|----|-------|
| 0  | 9.79 887 | 16 | 9.90 837 | 26    | 0.09 163 | 9.89 050 | 10 | 60 |       |
| 1  | 9.79 903 | 15 | 9.90 863 | 26    | 0.09 137 | 9.89 040 | 10 | 59 |       |
| 2  | 9.79 918 | 16 | 9.90 889 | 25    | 0.09 111 | 9.89 030 | 10 | 58 |       |
| 3  | 9.79 934 | 16 | 9.90 914 | 26    | 0.09 086 | 9.89 020 | 10 | 57 |       |
| 4  | 9.79 950 | 15 | 9.90 940 | 26    | 0.09 060 | 9.89 009 | 10 | 56 |       |
| 5  | 9.79 965 | 16 | 9.90 966 | 26    | 0.09 034 | 9.88 999 | 10 | 55 |       |
| 6  | 9.79 981 | 15 | 9.90 992 | 26    | 0.09 008 | 9.88 989 | 10 | 54 |       |
| 7  | 9.79 996 | 16 | 9.91 018 | 25    | 0.08 982 | 9.88 978 | 10 | 53 |       |
| 8  | 9.80 012 | 15 | 9.91 043 | 26    | 0.08 957 | 9.88 968 | 10 | 52 |       |
| 9  | 9.80 027 | 16 | 9.91 069 | 26    | 0.08 931 | 9.88 958 | 10 | 51 |       |
| 10 | 9.80 043 | 15 | 9.91 095 | 26    | 0.08 905 | 9.88 948 | 10 | 50 |       |
| 11 | 9.80 058 | 16 | 9.91 121 | 26    | 0.08 879 | 9.88 937 | 10 | 49 |       |
| 12 | 9.80 074 | 15 | 9.91 147 | 25    | 0.08 853 | 9.88 927 | 10 | 48 |       |
| 13 | 9.80 089 | 16 | 9.91 172 | 26    | 0.08 828 | 9.88 917 | 10 | 47 |       |
| 14 | 9.80 105 | 15 | 9.91 198 | 26    | 0.08 802 | 9.88 906 | 10 | 46 |       |
| 15 | 9.80 120 | 16 | 9.91 224 | 26    | 0.08 776 | 9.88 896 | 10 | 45 |       |
| 16 | 9.80 136 | 15 | 9.91 250 | 26    | 0.08 750 | 9.88 886 | 10 | 44 |       |
| 17 | 9.80 151 | 16 | 9.91 276 | 25    | 0.08 724 | 9.88 875 | 10 | 43 |       |
| 18 | 9.80 166 | 15 | 9.91 301 | 26    | 0.08 699 | 9.88 865 | 10 | 42 |       |
| 19 | 9.80 182 | 16 | 9.91 327 | 26    | 0.08 673 | 9.88 855 | 10 | 41 |       |
| 20 | 9.80 197 | 15 | 9.91 353 | 26    | 0.08 647 | 9.88 844 | 10 | 40 |       |
| 21 | 9.80 213 | 16 | 9.91 379 | 25    | 0.08 621 | 9.88 834 | 10 | 39 |       |
| 22 | 9.80 228 | 15 | 9.91 404 | 26    | 0.08 596 | 9.88 824 | 10 | 38 |       |
| 23 | 9.80 244 | 16 | 9.91 430 | 26    | 0.08 570 | 9.88 813 | 10 | 37 |       |
| 24 | 9.80 259 | 15 | 9.91 456 | 26    | 0.08 544 | 9.88 803 | 10 | 36 |       |
| 25 | 9.80 274 | 16 | 9.91 482 | 25    | 0.08 518 | 9.88 793 | 10 | 35 |       |
| 26 | 9.80 290 | 15 | 9.91 507 | 26    | 0.08 493 | 9.88 782 | 10 | 34 |       |
| 27 | 9.80 305 | 16 | 9.91 533 | 26    | 0.08 467 | 9.88 772 | 10 | 33 |       |
| 28 | 9.80 320 | 15 | 9.91 559 | 26    | 0.08 441 | 9.88 761 | 10 | 32 |       |
| 29 | 9.80 336 | 16 | 9.91 585 | 25    | 0.08 415 | 9.88 751 | 10 | 31 |       |
| 30 | 9.80 351 | 15 | 9.91 610 | 26    | 0.08 390 | 9.88 741 | 10 | 30 |       |
| 31 | 9.80 366 | 16 | 9.91 636 | 26    | 0.08 364 | 9.88 730 | 10 | 29 |       |
| 32 | 9.80 382 | 15 | 9.91 662 | 26    | 0.08 338 | 9.88 720 | 10 | 28 |       |
| 33 | 9.80 397 | 16 | 9.91 688 | 25    | 0.08 312 | 9.88 709 | 10 | 27 |       |
| 34 | 9.80 412 | 15 | 9.91 713 | 26    | 0.08 287 | 9.88 699 | 10 | 26 |       |
| 35 | 9.80 428 | 16 | 9.91 739 | 26    | 0.08 261 | 9.88 688 | 10 | 25 |       |
| 36 | 9.80 443 | 15 | 9.91 765 | 26    | 0.08 235 | 9.88 678 | 10 | 24 |       |
| 37 | 9.80 458 | 16 | 9.91 791 | 25    | 0.08 209 | 9.88 668 | 10 | 23 |       |
| 38 | 9.80 473 | 15 | 9.91 816 | 26    | 0.08 184 | 9.88 657 | 10 | 22 |       |
| 39 | 9.80 489 | 16 | 9.91 842 | 26    | 0.08 158 | 9.88 647 | 10 | 21 |       |
| 40 | 9.80 504 | 15 | 9.91 868 | 25    | 0.08 132 | 9.88 636 | 10 | 20 |       |
| 41 | 9.80 519 | 16 | 9.91 893 | 26    | 0.08 107 | 9.88 626 | 10 | 19 |       |
| 42 | 9.80 534 | 15 | 9.91 919 | 26    | 0.08 081 | 9.88 615 | 10 | 18 |       |
| 43 | 9.80 550 | 16 | 9.91 945 | 26    | 0.08 055 | 9.88 605 | 10 | 17 |       |
| 44 | 9.80 565 | 15 | 9.91 971 | 25    | 0.08 029 | 9.88 594 | 10 | 16 |       |
| 45 | 9.80 580 | 16 | 9.91 996 | 26    | 0.08 004 | 9.88 584 | 10 | 15 |       |
| 46 | 9.80 595 | 15 | 9.92 022 | 26    | 0.07 978 | 9.88 573 | 10 | 14 |       |
| 47 | 9.80 610 | 16 | 9.92 048 | 25    | 0.07 952 | 9.88 563 | 10 | 13 |       |
| 48 | 9.80 625 | 15 | 9.92 073 | 26    | 0.07 927 | 9.88 552 | 10 | 12 |       |
| 49 | 9.80 641 | 16 | 9.92 099 | 26    | 0.07 901 | 9.88 542 | 10 | 11 |       |
| 50 | 9.80 656 | 15 | 9.92 125 | 25    | 0.07 875 | 9.88 531 | 10 | 10 |       |
| 51 | 9.80 671 | 16 | 9.92 150 | 26    | 0.07 850 | 9.88 521 | 10 | 9  |       |
| 52 | 9.80 686 | 15 | 9.92 176 | 26    | 0.07 824 | 9.88 510 | 10 | 8  |       |
| 53 | 9.80 701 | 16 | 9.92 202 | 25    | 0.07 798 | 9.88 499 | 10 | 7  |       |
| 54 | 9.80 716 | 15 | 9.92 227 | 26    | 0.07 773 | 9.88 489 | 10 | 6  |       |
| 55 | 9.80 731 | 16 | 9.92 253 | 26    | 0.07 747 | 9.88 478 | 10 | 5  |       |
| 56 | 9.80 746 | 15 | 9.92 279 | 25    | 0.07 721 | 9.88 468 | 10 | 4  |       |
| 57 | 9.80 762 | 16 | 9.92 304 | 26    | 0.07 696 | 9.88 457 | 10 | 3  |       |
| 58 | 9.80 777 | 15 | 9.92 330 | 26    | 0.07 670 | 9.88 447 | 10 | 2  |       |
| 59 | 9.80 792 | 16 | 9.92 356 | 25    | 0.07 644 | 9.88 436 | 10 | 1  |       |
| 60 | 9.80 807 | 15 | 9.92 381 | 25    | 0.07 619 | 9.88 425 | 10 | 0  |       |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P. |



|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.          |
|----|----------|----|----------|-------|----------|----------|----|----|----------------|
| 0  | 9.80 807 | 15 | 9.92 381 | 26    | 0.07 619 | 9.88 425 | 10 | 60 |                |
| 1  | 9.80 822 | 15 | 9.92 407 | 26    | 0.07 593 | 9.88 415 | 11 | 59 |                |
| 2  | 9.80 837 | 15 | 9.92 433 | 25    | 0.07 567 | 9.88 404 | 11 | 58 |                |
| 3  | 9.80 852 | 15 | 9.92 458 | 25    | 0.07 542 | 9.88 394 | 11 | 57 | 26 25          |
| 4  | 9.80 867 | 15 | 9.92 484 | 26    | 0.07 516 | 9.88 383 | 11 | 56 | I 2.6 2.5      |
| 5  | 9.80 882 | 15 | 9.92 510 | 25    | 0.07 490 | 9.88 372 | 10 | 55 | 2 5.2 5.0      |
| 6  | 9.80 897 | 15 | 9.92 535 | 25    | 0.07 465 | 9.88 362 | 10 | 54 | 3 7.8 7.5      |
| 7  | 9.80 912 | 15 | 9.92 561 | 26    | 0.07 439 | 9.88 351 | 11 | 53 | 4 10.4 10.0    |
| 8  | 9.80 927 | 15 | 9.92 587 | 26    | 0.07 413 | 9.88 340 | 10 | 52 | 5 13.0 12.5    |
| 9  | 9.80 942 | 15 | 9.92 612 | 25    | 0.07 388 | 9.88 330 | 10 | 51 | 6 15.6 15.0    |
| 10 | 9.80 957 | 15 | 9.92 638 | 25    | 0.07 362 | 9.88 319 | 11 | 50 | 7 18.2 17.5    |
| 11 | 9.80 972 | 15 | 9.92 663 | 25    | 0.07 337 | 9.88 308 | 10 | 49 | 8 20.8 20.0    |
| 12 | 9.80 987 | 15 | 9.92 689 | 26    | 0.07 311 | 9.88 298 | 10 | 48 | 9 23.4 22.5    |
| 13 | 9.81 002 | 15 | 9.92 715 | 25    | 0.07 285 | 9.88 287 | 11 | 47 |                |
| 14 | 9.81 017 | 15 | 9.92 740 | 26    | 0.07 260 | 9.88 276 | 10 | 46 |                |
| 15 | 9.81 032 | 15 | 9.92 766 | 26    | 0.07 234 | 9.88 266 | 11 | 45 | 15 14          |
| 16 | 9.81 047 | 15 | 9.92 792 | 26    | 0.07 208 | 9.88 255 | 11 | 44 | I 1.5 1.4      |
| 17 | 9.81 061 | 14 | 9.92 817 | 25    | 0.07 183 | 9.88 244 | 10 | 43 | 2 3.0 2.8      |
| 18 | 9.81 076 | 15 | 9.92 843 | 26    | 0.07 157 | 9.88 234 | 11 | 42 | 3 4.5 4.2      |
| 19 | 9.81 091 | 15 | 9.92 868 | 25    | 0.07 132 | 9.88 223 | 11 | 41 | 4 6.0 5.6      |
| 20 | 9.81 106 | 15 | 9.92 894 | 26    | 0.07 106 | 9.88 212 | 11 | 40 | 5 7.5 7.0      |
| 21 | 9.81 121 | 15 | 9.92 920 | 25    | 0.07 080 | 9.88 201 | 10 | 39 | 6 9.0 8.4      |
| 22 | 9.81 136 | 15 | 9.92 945 | 25    | 0.07 055 | 9.88 191 | 10 | 38 | 7 10.5 9.8     |
| 23 | 9.81 151 | 15 | 9.92 971 | 26    | 0.07 029 | 9.88 180 | 11 | 37 | 8 12.0 11.2    |
| 24 | 9.81 166 | 14 | 9.92 996 | 25    | 0.07 004 | 9.88 169 | 11 | 36 | 9 13.5 12.6    |
| 25 | 9.81 180 | 15 | 9.93 022 | 26    | 0.06 978 | 9.88 158 | 10 | 35 |                |
| 26 | 9.81 195 | 15 | 9.93 048 | 25    | 0.06 952 | 9.88 148 | 10 | 34 |                |
| 27 | 9.81 210 | 15 | 9.93 073 | 25    | 0.06 927 | 9.88 137 | 11 | 33 |                |
| 28 | 9.81 225 | 15 | 9.93 099 | 26    | 0.06 901 | 9.88 126 | 11 | 32 | 11 10          |
| 29 | 9.81 240 | 14 | 9.93 124 | 25    | 0.06 876 | 9.88 115 | 11 | 31 | I 1.1 1.0      |
| 30 | 9.81 254 | 15 | 9.93 150 | 25    | 0.06 850 | 9.88 105 | 11 | 30 | 2 2.2 2.0      |
| 31 | 9.81 269 | 15 | 9.93 175 | 25    | 0.06 825 | 9.88 094 | 11 | 29 | 3 3.3 3.0      |
| 32 | 9.81 284 | 15 | 9.93 201 | 26    | 0.06 799 | 9.88 083 | 11 | 28 | 4 4.4 4.0      |
| 33 | 9.81 299 | 15 | 9.93 227 | 25    | 0.06 773 | 9.88 072 | 11 | 27 | 5 5.5 5.0      |
| 34 | 9.81 314 | 14 | 9.93 252 | 25    | 0.06 748 | 9.88 061 | 10 | 26 | 6 6.6 6.0      |
| 35 | 9.81 328 | 15 | 9.93 278 | 25    | 0.06 722 | 9.88 051 | 11 | 25 | 7 7.7 7.0      |
| 36 | 9.81 343 | 15 | 9.93 303 | 25    | 0.06 697 | 9.88 040 | 11 | 24 | 8 8.8 8.0      |
| 37 | 9.81 358 | 14 | 9.93 329 | 25    | 0.06 671 | 9.88 029 | 11 | 23 | 9 9.9 9.0      |
| 38 | 9.81 372 | 15 | 9.93 354 | 25    | 0.06 646 | 9.88 018 | 11 | 22 |                |
| 39 | 9.81 387 | 15 | 9.93 380 | 26    | 0.06 620 | 9.88 007 | 11 | 21 |                |
| 40 | 9.81 402 | 15 | 9.93 406 | 25    | 0.06 594 | 9.87 996 | 11 | 20 |                |
| 41 | 9.81 417 | 14 | 9.93 431 | 25    | 0.06 569 | 9.87 985 | 10 | 19 |                |
| 42 | 9.81 431 | 15 | 9.93 457 | 25    | 0.06 543 | 9.87 975 | 10 | 18 |                |
| 43 | 9.81 446 | 15 | 9.93 482 | 26    | 0.06 518 | 9.87 964 | 11 | 17 |                |
| 44 | 9.81 461 | 14 | 9.93 508 | 25    | 0.06 492 | 9.87 953 | 11 | 16 | 11 10 10       |
| 45 | 9.81 475 | 15 | 9.93 533 | 25    | 0.06 467 | 9.87 942 | 11 | 15 | 26 26 25       |
| 46 | 9.81 490 | 15 | 9.93 559 | 26    | 0.06 441 | 9.87 931 | 11 | 14 |                |
| 47 | 9.81 505 | 14 | 9.93 584 | 25    | 0.06 416 | 9.87 920 | 11 | 13 | I 1.2 1.3 1.2  |
| 48 | 9.81 519 | 15 | 9.93 610 | 26    | 0.06 390 | 9.87 909 | 11 | 12 | 3.5 3.9 3.8    |
| 49 | 9.81 534 | 15 | 9.93 636 | 25    | 0.06 364 | 9.87 898 | 11 | 11 | 5.9 6.5 6.2    |
| 50 | 9.81 549 | 14 | 9.93 661 | 25    | 0.06 339 | 9.87 887 | 11 | 10 | 8.3 9.1 8.8    |
| 51 | 9.81 563 | 15 | 9.93 687 | 25    | 0.06 313 | 9.87 877 | 10 | 9  | 10.6 11.7 11.2 |
| 52 | 9.81 578 | 14 | 9.93 712 | 26    | 0.06 288 | 9.87 866 | 10 | 8  | 13.0 14.3 13.8 |
| 53 | 9.81 592 | 15 | 9.93 738 | 26    | 0.06 262 | 9.87 855 | 11 | 7  | 15.4 16.9 16.2 |
| 54 | 9.81 607 | 15 | 9.93 763 | 25    | 0.06 237 | 9.87 844 | 11 | 6  | 17.7 19.5 18.8 |
| 55 | 9.81 622 | 15 | 9.93 789 | 25    | 0.06 211 | 9.87 833 | 11 | 5  | 20.1 22.1 21.2 |
| 56 | 9.81 636 | 14 | 9.93 814 | 26    | 0.06 186 | 9.87 822 | 11 | 4  | 22.5 24.7 23.8 |
| 57 | 9.81 651 | 14 | 9.93 840 | 25    | 0.06 160 | 9.87 811 | 11 | 3  | 24.8 — —       |
| 58 | 9.81 665 | 15 | 9.93 865 | 25    | 0.06 135 | 9.87 800 | 11 | 2  |                |
| 59 | 9.81 680 | 15 | 9.93 891 | 26    | 0.06 109 | 9.87 789 | 11 | 1  |                |
| 60 | 9.81 694 | 14 | 9.93 916 | 25    | 0.06 084 | 9.87 778 | 11 | 0  |                |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Sin.  | d.       |    |    | P. P.          |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.             |
|----|----------|----|----------|-------|----------|----------|----|----|-------------------|
| 0  | 9.81 694 | 15 | 9.93 916 | 26    | 0.06 084 | 9.87 778 | 11 | 60 |                   |
| 1  | 9.81 709 | 14 | 9.93 942 | 25    | 0.06 058 | 9.87 767 | 11 | 59 |                   |
| 2  | 9.81 723 | 15 | 9.93 967 | 26    | 0.06 033 | 9.87 756 | 11 | 58 |                   |
| 3  | 9.81 738 | 15 | 9.93 993 | 26    | 0.06 007 | 9.87 745 | 11 | 57 | 26 25             |
| 4  | 9.81 752 | 14 | 9.94 018 | 25    | 0.05 982 | 9.87 734 | 11 | 56 |                   |
| 5  | 9.81 767 | 15 | 9.94 044 | 26    | 0.05 956 | 9.87 723 | 11 | 55 | 1 2.6 2.5         |
| 6  | 9.81 781 | 14 | 9.94 069 | 25    | 0.05 931 | 9.87 712 | 11 | 54 | 2 5.2 5.0         |
| 7  | 9.81 796 | 15 | 9.94 095 | 25    | 0.05 905 | 9.87 701 | 11 | 53 | 3 7.8 7.5         |
| 8  | 9.81 810 | 14 | 9.94 120 | 25    | 0.05 880 | 9.87 690 | 11 | 52 | 4 10.4 10.0       |
| 9  | 9.81 825 | 15 | 9.94 146 | 26    | 0.05 854 | 9.87 679 | 11 | 51 | 5 13.0 12.5       |
| 10 | 9.81 839 | 14 | 9.94 171 | 25    | 0.05 829 | 9.87 668 | 11 | 50 | 6 15.6 15.0       |
| 11 | 9.81 854 | 15 | 9.94 197 | 26    | 0.05 803 | 9.87 657 | 11 | 49 | 7 18.2 17.5       |
| 12 | 9.81 868 | 14 | 9.94 222 | 25    | 0.05 778 | 9.87 646 | 11 | 48 | 8 20.8 20.0       |
| 13 | 9.81 882 | 14 | 9.94 248 | 26    | 0.05 752 | 9.87 635 | 11 | 47 | 9 23.4 22.5       |
| 14 | 9.81 897 | 15 | 9.94 273 | 25    | 0.05 727 | 9.87 624 | 11 | 46 |                   |
| 15 | 9.81 911 | 14 | 9.94 299 | 26    | 0.05 701 | 9.87 613 | 12 | 45 | 15 14             |
| 16 | 9.81 926 | 15 | 9.94 324 | 25    | 0.05 676 | 9.87 601 | 11 | 44 |                   |
| 17 | 9.81 940 | 14 | 9.94 350 | 25    | 0.05 650 | 9.87 590 | 11 | 43 | 1 1.5 1.4         |
| 18 | 9.81 955 | 15 | 9.94 375 | 25    | 0.05 625 | 9.87 579 | 11 | 42 | 2 3.0 2.8         |
| 19 | 9.81 969 | 14 | 9.94 401 | 26    | 0.05 599 | 9.87 568 | 11 | 41 | 3 4.5 4.2         |
| 20 | 9.81 983 | 15 | 9.94 426 | 25    | 0.05 574 | 9.87 557 | 11 | 40 | 4 6.0 5.6         |
| 21 | 9.81 998 | 14 | 9.94 452 | 26    | 0.05 548 | 9.87 546 | 11 | 39 | 5 7.5 7.0         |
| 22 | 9.82 012 | 15 | 9.94 477 | 25    | 0.05 523 | 9.87 535 | 11 | 38 | 6 9.0 8.4         |
| 23 | 9.82 026 | 14 | 9.94 503 | 25    | 0.05 497 | 9.87 524 | 11 | 37 | 7 10.5 9.8        |
| 24 | 9.82 041 | 15 | 9.94 528 | 25    | 0.05 472 | 9.87 513 | 12 | 36 | 8 12.0 11.2       |
| 25 | 9.82 055 | 14 | 9.94 554 | 25    | 0.05 446 | 9.87 501 | 11 | 35 | 9 13.5 12.6       |
| 26 | 9.82 069 | 14 | 9.94 579 | 25    | 0.05 421 | 9.87 490 | 11 | 34 |                   |
| 27 | 9.82 084 | 15 | 9.94 604 | 26    | 0.05 396 | 9.87 479 | 11 | 33 |                   |
| 28 | 9.82 098 | 14 | 9.94 630 | 26    | 0.05 370 | 9.87 468 | 11 | 32 |                   |
| 29 | 9.82 112 | 14 | 9.94 655 | 25    | 0.05 345 | 9.87 457 | 11 | 31 | 12 11             |
| 30 | 9.82 126 | 15 | 9.94 681 | 25    | 0.05 319 | 9.87 446 | 12 | 30 | 1 1.2 1.1         |
| 31 | 9.82 141 | 14 | 9.94 706 | 26    | 0.05 294 | 9.87 434 | 11 | 29 | 2 2.4 2.2         |
| 32 | 9.82 155 | 14 | 9.94 732 | 25    | 0.05 268 | 9.87 423 | 11 | 28 | 3 3.6 3.3         |
| 33 | 9.82 169 | 14 | 9.94 757 | 25    | 0.05 243 | 9.87 412 | 11 | 27 | 4 4.8 4.4         |
| 34 | 9.82 184 | 15 | 9.94 783 | 25    | 0.05 217 | 9.87 401 | 11 | 26 | 5 6.0 5.5         |
| 35 | 9.82 198 | 14 | 9.94 808 | 25    | 0.05 192 | 9.87 390 | 12 | 25 | 6 7.2 6.6         |
| 36 | 9.82 212 | 14 | 9.94 834 | 26    | 0.05 166 | 9.87 378 | 11 | 24 | 7 8.4 7.7         |
| 37 | 9.82 226 | 14 | 9.94 859 | 25    | 0.05 141 | 9.87 367 | 11 | 23 | 8 9.6 8.8         |
| 38 | 9.82 240 | 14 | 9.94 884 | 25    | 0.05 116 | 9.87 356 | 11 | 22 | 9 10.8 9.9        |
| 39 | 9.82 255 | 15 | 9.94 910 | 26    | 0.05 090 | 9.87 345 | 11 | 21 |                   |
| 40 | 9.82 269 | 14 | 9.94 935 | 25    | 0.05 065 | 9.87 334 | 12 | 20 |                   |
| 41 | 9.82 283 | 14 | 9.94 961 | 25    | 0.05 039 | 9.87 322 | 11 | 19 |                   |
| 42 | 9.82 297 | 14 | 9.94 986 | 26    | 0.05 014 | 9.87 311 | 11 | 18 |                   |
| 43 | 9.82 311 | 15 | 9.95 012 | 25    | 0.04 988 | 9.87 300 | 11 | 17 |                   |
| 44 | 9.82 326 | 14 | 9.95 037 | 25    | 0.04 963 | 9.87 288 | 12 | 16 | 12 12 11          |
| 45 | 9.82 340 | 14 | 9.95 062 | 25    | 0.04 938 | 9.87 277 | 11 | 15 | 26 25 25          |
| 46 | 9.82 354 | 14 | 9.95 088 | 26    | 0.04 912 | 9.87 266 | 11 | 14 |                   |
| 47 | 9.82 368 | 14 | 9.95 113 | 25    | 0.04 887 | 9.87 255 | 12 | 13 | 1 1.1 1.0 1.1     |
| 48 | 9.82 382 | 14 | 9.95 139 | 26    | 0.04 861 | 9.87 243 | 11 | 12 | 2 3.2 3.1 3.4     |
| 49 | 9.82 396 | 14 | 9.95 164 | 25    | 0.04 836 | 9.87 232 | 11 | 11 | 3 5.4 5.2 5.7     |
| 50 | 9.82 410 | 14 | 9.95 190 | 25    | 0.04 810 | 9.87 221 | 12 | 10 | 4 7.6 7.3 8.0     |
| 51 | 9.82 424 | 15 | 9.95 215 | 25    | 0.04 785 | 9.87 209 | 12 | 9  | 5 9.8 9.4 10.2    |
| 52 | 9.82 439 | 15 | 9.95 240 | 26    | 0.04 760 | 9.87 198 | 11 | 8  | 6 11.9 11.5 12.5  |
| 53 | 9.82 453 | 14 | 9.95 266 | 25    | 0.04 734 | 9.87 187 | 11 | 7  | 7 14.1 13.5 14.8  |
| 54 | 9.82 467 | 14 | 9.95 291 | 25    | 0.04 709 | 9.87 175 | 12 | 6  | 8 16.2 15.6 17.0  |
| 55 | 9.82 481 | 14 | 9.95 317 | 25    | 0.04 683 | 9.87 164 | 11 | 5  | 9 18.4 17.7 19.3  |
| 56 | 9.82 495 | 14 | 9.95 342 | 26    | 0.04 658 | 9.87 153 | 12 | 4  | 10 20.6 19.8 21.6 |
| 57 | 9.82 509 | 14 | 9.95 368 | 25    | 0.04 632 | 9.87 141 | 11 | 3  | 11 22.8 21.9 23.9 |
| 58 | 9.82 523 | 14 | 9.95 393 | 25    | 0.04 607 | 9.87 130 | 11 | 2  | 12 24.9 24.0 —    |
| 59 | 9.82 537 | 14 | 9.95 418 | 25    | 0.04 582 | 9.87 119 | 12 | 1  |                   |
| 60 | 9.82 551 | 14 | 9.95 444 | 26    | 0.04 556 | 9.87 107 | 12 | 0  |                   |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Sin.  | d.       |    |    | P. P.             |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.             |
|----|----------|----|----------|-------|----------|----------|----|----|-------------------|
| 0  | 9.82 551 | 14 | 9.95 444 | 25    | 0.04 556 | 9.87 107 | 11 | 60 |                   |
| 1  | 9.82 565 | 14 | 9.95 469 | 26    | 0.04 531 | 9.87 096 | 11 | 59 |                   |
| 2  | 9.82 579 | 14 | 9.95 495 | 25    | 0.04 505 | 9.87 085 | 11 | 58 |                   |
| 3  | 9.82 593 | 14 | 9.95 520 | 25    | 0.04 480 | 9.87 073 | 11 | 57 | 26 25             |
| 4  | 9.82 607 | 14 | 9.95 545 | 26    | 0.04 455 | 9.87 062 | 11 | 56 |                   |
| 5  | 9.82 621 | 14 | 9.95 571 | 25    | 0.04 429 | 9.87 050 | 11 | 55 | 1 2.6 2.5         |
| 6  | 9.82 635 | 14 | 9.95 596 | 25    | 0.04 404 | 9.87 039 | 11 | 54 | 2 5.2 5.0         |
| 7  | 9.82 649 | 14 | 9.95 622 | 26    | 0.04 378 | 9.87 028 | 11 | 53 | 3 7.8 7.5         |
| 8  | 9.82 663 | 14 | 9.95 647 | 25    | 0.04 353 | 9.87 016 | 11 | 52 | 4 10.4 10.0       |
| 9  | 9.82 677 | 14 | 9.95 672 | 26    | 0.04 328 | 9.87 005 | 11 | 51 | 5 13.0 12.5       |
| 10 | 9.82 691 | 14 | 9.95 698 | 25    | 0.04 302 | 9.86 993 | 11 | 50 | 6 15.6 15.0       |
| 11 | 9.82 705 | 14 | 9.95 723 | 25    | 0.04 277 | 9.86 982 | 11 | 49 | 7 18.2 17.5       |
| 12 | 9.82 719 | 14 | 9.95 748 | 25    | 0.04 252 | 9.86 970 | 11 | 48 | 8 20.8 20.0       |
| 13 | 9.82 733 | 14 | 9.95 774 | 25    | 0.04 226 | 9.86 959 | 11 | 47 | 9 23.4 22.5       |
| 14 | 9.82 747 | 14 | 9.95 799 | 26    | 0.04 201 | 9.86 947 | 11 | 46 |                   |
| 15 | 9.82 761 | 14 | 9.95 825 | 25    | 0.04 175 | 9.86 936 | 11 | 45 |                   |
| 16 | 9.82 775 | 14 | 9.95 850 | 25    | 0.04 150 | 9.86 924 | 11 | 44 | 14 13             |
| 17 | 9.82 788 | 13 | 9.95 875 | 25    | 0.04 125 | 9.86 913 | 11 | 43 | 1 1.4 1.3         |
| 18 | 9.82 802 | 14 | 9.95 901 | 26    | 0.04 099 | 9.86 902 | 11 | 42 | 2 2.8 2.6         |
| 19 | 9.82 816 | 14 | 9.95 926 | 26    | 0.04 074 | 9.86 890 | 11 | 41 | 3 4.2 3.9         |
| 20 | 9.82 830 | 14 | 9.95 952 | 25    | 0.04 048 | 9.86 879 | 11 | 40 | 4 5.6 5.2         |
| 21 | 9.82 844 | 14 | 9.95 977 | 25    | 0.04 023 | 9.86 867 | 11 | 39 | 5 7.0 6.5         |
| 22 | 9.82 858 | 14 | 9.96 002 | 25    | 0.03 998 | 9.86 855 | 11 | 38 | 6 8.4 7.8         |
| 23 | 9.82 872 | 14 | 9.96 028 | 26    | 0.03 972 | 9.86 844 | 11 | 37 | 7 9.8 9.1         |
| 24 | 9.82 885 | 13 | 9.96 053 | 25    | 0.03 947 | 9.86 832 | 11 | 36 | 8 11.2 10.4       |
| 25 | 9.82 899 | 14 | 9.96 078 | 26    | 0.03 922 | 9.86 821 | 11 | 35 | 9 12.6 11.7       |
| 26 | 9.82 913 | 14 | 9.96 104 | 26    | 0.03 896 | 9.86 809 | 11 | 34 |                   |
| 27 | 9.82 927 | 14 | 9.96 129 | 25    | 0.03 871 | 9.86 798 | 11 | 33 |                   |
| 28 | 9.82 941 | 14 | 9.96 155 | 26    | 0.03 845 | 9.86 786 | 11 | 32 | 12 11             |
| 29 | 9.82 955 | 13 | 9.96 180 | 25    | 0.03 820 | 9.86 775 | 11 | 31 | 1 1.2 1.1         |
| 30 | 9.82 968 | 14 | 9.96 205 | 26    | 0.03 795 | 9.86 763 | 11 | 30 | 2 2.4 2.2         |
| 31 | 9.82 982 | 14 | 9.96 231 | 25    | 0.03 769 | 9.86 752 | 11 | 29 | 3 3.6 3.3         |
| 32 | 9.82 996 | 14 | 9.96 256 | 25    | 0.03 744 | 9.86 740 | 11 | 28 | 4 4.8 4.4         |
| 33 | 9.83 010 | 14 | 9.96 281 | 25    | 0.03 719 | 9.86 728 | 11 | 27 | 5 6.0 5.5         |
| 34 | 9.83 023 | 13 | 9.96 307 | 26    | 0.03 693 | 9.86 717 | 11 | 26 | 6 7.2 6.6         |
| 35 | 9.83 037 | 14 | 9.96 332 | 25    | 0.03 668 | 9.86 705 | 11 | 25 | 7 8.4 7.7         |
| 36 | 9.83 051 | 14 | 9.96 357 | 25    | 0.03 643 | 9.86 694 | 11 | 24 | 8 9.6 8.8         |
| 37 | 9.83 065 | 14 | 9.96 383 | 26    | 0.03 617 | 9.86 682 | 11 | 23 | 9 10.8 9.9        |
| 38 | 9.83 078 | 13 | 9.96 408 | 25    | 0.03 592 | 9.86 670 | 11 | 22 |                   |
| 39 | 9.83 092 | 14 | 9.96 433 | 26    | 0.03 567 | 9.86 659 | 11 | 21 |                   |
| 40 | 9.83 106 | 14 | 9.96 459 | 25    | 0.03 541 | 9.86 647 | 11 | 20 |                   |
| 41 | 9.83 120 | 14 | 9.96 484 | 25    | 0.03 516 | 9.86 635 | 11 | 19 |                   |
| 42 | 9.83 133 | 13 | 9.96 510 | 26    | 0.03 490 | 9.86 624 | 11 | 18 |                   |
| 43 | 9.83 147 | 14 | 9.96 535 | 25    | 0.03 465 | 9.86 612 | 11 | 17 | 12 11 11          |
| 44 | 9.83 161 | 13 | 9.96 560 | 25    | 0.03 440 | 9.86 600 | 11 | 16 | 26 26 25          |
| 45 | 9.83 174 | 13 | 9.96 586 | 26    | 0.03 414 | 9.86 589 | 11 | 15 |                   |
| 46 | 9.83 188 | 14 | 9.96 611 | 25    | 0.03 389 | 9.86 577 | 11 | 14 | 0 1.1 1.2 1.1     |
| 47 | 9.83 202 | 14 | 9.96 636 | 25    | 0.03 364 | 9.86 565 | 11 | 13 | 2 3.2 3.5 3.4     |
| 48 | 9.83 215 | 13 | 9.96 662 | 26    | 0.03 338 | 9.86 554 | 11 | 12 | 3 5.4 5.9 5.7     |
| 49 | 9.83 229 | 13 | 9.96 687 | 25    | 0.03 313 | 9.86 542 | 11 | 11 | 4 7.6 8.3 8.0     |
| 50 | 9.83 242 | 14 | 9.96 712 | 25    | 0.03 288 | 9.86 530 | 11 | 10 | 5 9.8 10.6 10.2   |
| 51 | 9.83 256 | 14 | 9.96 738 | 26    | 0.03 262 | 9.86 518 | 11 | 9  | 6 11.9 13.0 12.5  |
| 52 | 9.83 270 | 14 | 9.96 763 | 25    | 0.03 237 | 9.86 507 | 11 | 8  | 7 14.1 15.4 14.8  |
| 53 | 9.83 283 | 13 | 9.96 788 | 25    | 0.03 212 | 9.86 495 | 11 | 7  | 8 16.2 17.7 17.0  |
| 54 | 9.83 297 | 13 | 9.96 814 | 26    | 0.03 186 | 9.86 483 | 11 | 6  | 9 18.4 20.1 19.3  |
| 55 | 9.83 310 | 14 | 9.96 839 | 25    | 0.03 161 | 9.86 472 | 11 | 5  | 10 20.6 22.5 21.6 |
| 56 | 9.83 324 | 14 | 9.96 864 | 25    | 0.03 136 | 9.86 460 | 11 | 4  | 11 22.8 24.8 23.9 |
| 57 | 9.83 338 | 14 | 9.96 890 | 26    | 0.03 110 | 9.86 448 | 11 | 3  | 12 24.9 — —       |
| 58 | 9.83 351 | 13 | 9.96 915 | 25    | 0.03 085 | 9.86 436 | 11 | 2  |                   |
| 59 | 9.83 365 | 13 | 9.96 940 | 25    | 0.03 060 | 9.86 425 | 11 | 1  |                   |
| 60 | 9.83 378 | 14 | 9.96 966 | 26    | 0.03 034 | 9.86 413 | 11 | 0  |                   |
|    | L. Cos.  | d. | L. Cot.  | c. d. | L. Tan.  | L. Sin.  | d. |    | P. P.             |

|    | L. Sin.  | d. | L. Tan.  | c. d. | L. Cot.  | L. Cos.  | d. |    | P. P.        |
|----|----------|----|----------|-------|----------|----------|----|----|--------------|
| 0  | 9.83 378 | 14 | 9.96 966 | 25    | 0.03 034 | 9.86 413 | 12 | 60 |              |
| 1  | 9.83 392 | 13 | 9.96 991 | 25    | 0.03 009 | 9.86 401 | 12 | 59 |              |
| 2  | 9.83 405 | 14 | 9.97 016 | 26    | 0.02 984 | 9.86 389 | 12 | 58 |              |
| 3  | 9.83 419 | 13 | 9.97 042 | 25    | 0.02 958 | 9.86 377 | 11 | 57 | 26 25        |
| 4  | 9.83 432 | 14 | 9.97 067 | 25    | 0.02 933 | 9.86 366 | 12 | 56 | I 2.6 2.5    |
| 5  | 9.83 446 | 13 | 9.97 092 | 26    | 0.02 908 | 9.86 354 | 12 | 55 | 2 5.2 5.0    |
| 6  | 9.83 459 | 14 | 9.97 118 | 25    | 0.02 882 | 9.86 342 | 12 | 54 | 3 7.8 7.5    |
| 7  | 9.83 473 | 13 | 9.97 143 | 25    | 0.02 857 | 9.86 330 | 12 | 53 | 4 10.4 10.0  |
| 8  | 9.83 486 | 14 | 9.97 168 | 25    | 0.02 832 | 9.86 318 | 12 | 52 | 5 13.0 12.5  |
| 9  | 9.83 500 | 13 | 9.97 193 | 26    | 0.02 807 | 9.86 306 | 12 | 51 | 6 15.6 15.0  |
| 10 | 9.83 513 | 14 | 9.97 219 | 25    | 0.02 781 | 9.86 295 | 12 | 50 | 7 18.2 17.5  |
| 11 | 9.83 527 | 13 | 9.97 244 | 25    | 0.02 756 | 9.86 283 | 12 | 49 | 8 20.8 20.0  |
| 12 | 9.83 540 | 14 | 9.97 269 | 26    | 0.02 731 | 9.86 271 | 12 | 48 | 9 23.4 22.5  |
| 13 | 9.83 554 | 13 | 9.97 295 | 25    | 0.02 705 | 9.86 259 | 12 | 47 |              |
| 14 | 9.83 567 | 14 | 9.97 320 | 25    | 0.02 680 | 9.86 247 | 12 | 46 |              |
| 15 | 9.83 581 | 13 | 9.97 345 | 26    | 0.02 655 | 9.86 235 | 12 | 45 | 14 13        |
| 16 | 9.83 594 | 14 | 9.97 371 | 25    | 0.02 629 | 9.86 223 | 12 | 44 | I 1.4 1.3    |
| 17 | 9.83 608 | 13 | 9.97 396 | 25    | 0.02 604 | 9.86 211 | 11 | 43 | 2 2.8 2.6    |
| 18 | 9.83 621 | 14 | 9.97 421 | 26    | 0.02 579 | 9.86 200 | 12 | 42 | 3 4.2 3.9    |
| 19 | 9.83 634 | 13 | 9.97 447 | 25    | 0.02 553 | 9.86 188 | 12 | 41 | 4 5.6 5.2    |
| 20 | 9.83 648 | 14 | 9.97 472 | 25    | 0.02 528 | 9.86 176 | 12 | 40 | 5 7.0 6.5    |
| 21 | 9.83 661 | 13 | 9.97 497 | 26    | 0.02 503 | 9.86 164 | 12 | 39 | 6 8.4 7.8    |
| 22 | 9.83 674 | 14 | 9.97 523 | 25    | 0.02 477 | 9.86 152 | 12 | 38 | 7 9.8 9.1    |
| 23 | 9.83 688 | 13 | 9.97 548 | 25    | 0.02 452 | 9.86 140 | 12 | 37 | 8 11.2 10.4  |
| 24 | 9.83 701 | 14 | 9.97 573 | 25    | 0.02 427 | 9.86 128 | 12 | 36 | 9 12.6 11.7  |
| 25 | 9.83 715 | 13 | 9.97 598 | 26    | 0.02 402 | 9.86 116 | 12 | 35 |              |
| 26 | 9.83 728 | 14 | 9.97 624 | 25    | 0.02 376 | 9.86 104 | 12 | 34 |              |
| 27 | 9.83 741 | 13 | 9.97 649 | 25    | 0.02 351 | 9.86 092 | 12 | 33 | 12 11        |
| 28 | 9.83 755 | 14 | 9.97 674 | 26    | 0.02 326 | 9.86 080 | 12 | 32 | I 1.2 1.1    |
| 29 | 9.83 768 | 13 | 9.97 700 | 25    | 0.02 300 | 9.86 068 | 12 | 31 | 2 2.4 2.2    |
| 30 | 9.83 781 | 14 | 9.97 725 | 25    | 0.02 275 | 9.86 056 | 12 | 30 | 3 3.6 3.3    |
| 31 | 9.83 795 | 13 | 9.97 750 | 26    | 0.02 250 | 9.86 044 | 12 | 29 | 4 4.8 4.4    |
| 32 | 9.83 808 | 14 | 9.97 776 | 25    | 0.02 224 | 9.86 032 | 12 | 28 | 5 6.0 5.5    |
| 33 | 9.83 821 | 13 | 9.97 801 | 25    | 0.02 199 | 9.86 020 | 12 | 27 | 6 7.2 6.6    |
| 34 | 9.83 834 | 14 | 9.97 826 | 25    | 0.02 174 | 9.86 008 | 12 | 26 | 7 8.4 7.7    |
| 35 | 9.83 848 | 13 | 9.97 851 | 26    | 0.02 149 | 9.85 996 | 12 | 25 | 8 9.6 8.8    |
| 36 | 9.83 861 | 14 | 9.97 877 | 25    | 0.02 123 | 9.85 984 | 12 | 24 | 9 10.8 9.9   |
| 37 | 9.83 874 | 13 | 9.97 902 | 25    | 0.02 098 | 9.85 972 | 12 | 23 |              |
| 38 | 9.83 887 | 14 | 9.97 927 | 26    | 0.02 073 | 9.85 960 | 12 | 22 |              |
| 39 | 9.83 901 | 13 | 9.97 953 | 25    | 0.02 047 | 9.85 948 | 12 | 21 |              |
| 40 | 9.83 914 | 14 | 9.97 978 | 25    | 0.02 022 | 9.85 936 | 12 | 20 |              |
| 41 | 9.83 927 | 13 | 9.98 003 | 26    | 0.01 997 | 9.85 924 | 12 | 19 |              |
| 42 | 9.83 940 | 14 | 9.98 029 | 25    | 0.01 971 | 9.85 912 | 12 | 18 |              |
| 43 | 9.83 954 | 13 | 9.98 054 | 25    | 0.01 946 | 9.85 900 | 12 | 17 | 13 13 12     |
| 44 | 9.83 967 | 14 | 9.98 079 | 25    | 0.01 921 | 9.85 888 | 12 | 16 | 26 25 25     |
| 45 | 9.83 980 | 13 | 9.98 104 | 26    | 0.01 896 | 9.85 876 | 12 | 15 | 0 1.0 1.0    |
| 46 | 9.83 993 | 14 | 9.98 130 | 25    | 0.01 870 | 9.85 864 | 12 | 14 | 1 3.0 2.9    |
| 47 | 9.84 006 | 13 | 9.98 155 | 25    | 0.01 845 | 9.85 851 | 13 | 13 | 2 5.0 4.8    |
| 48 | 9.84 020 | 14 | 9.98 180 | 26    | 0.01 820 | 9.85 839 | 12 | 12 | 3 7.0 6.7    |
| 49 | 9.84 033 | 13 | 9.98 206 | 25    | 0.01 794 | 9.85 827 | 12 | 11 | 4 9.0 8.7    |
| 50 | 9.84 046 | 14 | 9.98 231 | 25    | 0.01 769 | 9.85 815 | 12 | 10 | 5 11.0 10.6  |
| 51 | 9.84 059 | 13 | 9.98 256 | 26    | 0.01 744 | 9.85 803 | 12 | 9  | 6 13.0 12.5  |
| 52 | 9.84 072 | 14 | 9.98 281 | 25    | 0.01 719 | 9.85 791 | 12 | 8  | 7 15.0 14.4  |
| 53 | 9.84 085 | 13 | 9.98 307 | 25    | 0.01 693 | 9.85 779 | 12 | 7  | 8 17.0 16.3  |
| 54 | 9.84 098 | 14 | 9.98 332 | 26    | 0.01 668 | 9.85 766 | 13 | 6  | 9 19.0 18.3  |
| 55 | 9.84 112 | 13 | 9.98 357 | 25    | 0.01 643 | 9.85 754 | 12 | 5  | 10 21.0 20.2 |
| 56 | 9.84 125 | 14 | 9.98 383 | 26    | 0.01 617 | 9.85 742 | 12 | 4  | 11 23.0 22.1 |
| 57 | 9.84 138 | 13 | 9.98 408 | 25    | 0.01 592 | 9.85 730 | 12 | 3  | 12 25.0 24.0 |
| 58 | 9.84 151 | 14 | 9.98 433 | 25    | 0.01 567 | 9.85 718 | 12 | 2  |              |
| 59 | 9.84 164 | 13 | 9.98 458 | 26    | 0.01 542 | 9.85 706 | 12 | 1  |              |
| 60 | 9.84 177 | 14 | 9.98 484 | 25    | 0.01 516 | 9.85 693 | 13 | 0  |              |
|    | L. Cos.  | d. | L. Tan.  | c. d. | L. Sin.  | d.       |    |    | P. P.        |



III.

NATURAL

TRIGONOMETRIC FUNCTIONS

FOR EACH MINUTE.

| '       | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|---------|---------|---------|---------|---------|----|
| 0       | .00000  | .00000  | ∞       | 1.0000  | 60 |
| 1       | .029    | .029    | 3437.7  | .000    | 59 |
| 2       | .058    | .058    | 1718.9  | .000    | 58 |
| 3       | .087    | .087    | 1145.9  | .000    | 57 |
| 4       | .116    | .116    | 859.44  | .000    | 56 |
| 5       | .00145  | .00145  | 687.55  | 1.0000  | 55 |
| 6       | .175    | .175    | 572.96  | .000    | 54 |
| 7       | .204    | .204    | 491.11  | .000    | 53 |
| 8       | .233    | .233    | 429.72  | .000    | 52 |
| 9       | .262    | .262    | 381.97  | .000    | 51 |
| 10      | .00291  | .00291  | 343.77  | 1.0000  | 50 |
| 11      | .320    | .320    | 312.52  | .99999  | 49 |
| 12      | .349    | .349    | 286.48  | .999    | 48 |
| 13      | .378    | .378    | 264.44  | .999    | 47 |
| 14      | .407    | .407    | 245.55  | .999    | 46 |
| 15      | .00436  | .00436  | 229.18  | .99999  | 45 |
| 16      | .465    | .465    | 214.86  | .999    | 44 |
| 17      | .495    | .495    | 202.22  | .999    | 43 |
| 18      | .524    | .524    | 190.98  | .999    | 42 |
| 19      | .553    | .553    | 180.93  | .998    | 41 |
| 20      | .00582  | .00582  | 171.89  | .99998  | 40 |
| 21      | .611    | .611    | 163.70  | .998    | 39 |
| 22      | .640    | .640    | 156.26  | .998    | 38 |
| 23      | .669    | .669    | 149.47  | .998    | 37 |
| 24      | .698    | .698    | 143.24  | .998    | 36 |
| 25      | .00727  | .00727  | 137.51  | .99997  | 35 |
| 26      | .756    | .756    | 132.22  | .997    | 34 |
| 27      | .785    | .785    | 127.32  | .997    | 33 |
| 28      | .814    | .814    | 122.77  | .997    | 32 |
| 29      | .844    | .844    | 118.54  | .996    | 31 |
| 30      | .00873  | .00873  | 114.59  | .99996  | 30 |
| 31      | .902    | .902    | 110.89  | .996    | 29 |
| 32      | .931    | .931    | 107.43  | .996    | 28 |
| 33      | .960    | .960    | 104.17  | .995    | 27 |
| 34      | .00989  | .00989  | 101.11  | .995    | 26 |
| 35      | .01018  | .01018  | 98.218  | .99995  | 25 |
| 36      | .047    | .047    | 95.489  | .995    | 24 |
| 37      | .076    | .076    | 92.908  | .994    | 23 |
| 38      | .105    | .105    | 90.463  | .994    | 22 |
| 39      | .134    | .135    | 88.144  | .994    | 21 |
| 40      | .01164  | .01164  | 85.940  | .99993  | 20 |
| 41      | .193    | .193    | 83.844  | .993    | 19 |
| 42      | .222    | .222    | 81.847  | .993    | 18 |
| 43      | .251    | .251    | 79.943  | .992    | 17 |
| 44      | .280    | .280    | 78.126  | .992    | 16 |
| 45      | .01309  | .01309  | 76.390  | .99991  | 15 |
| 46      | .338    | .338    | 74.729  | .991    | 14 |
| 47      | .367    | .367    | 73.139  | .991    | 13 |
| 48      | .396    | .396    | 71.615  | .990    | 12 |
| 49      | .425    | .425    | 70.153  | .990    | 11 |
| 50      | .01454  | .01455  | 68.750  | .99989  | 10 |
| 51      | .483    | .484    | 67.402  | .989    | 9  |
| 52      | .513    | .513    | 66.105  | .989    | 8  |
| 53      | .542    | .542    | 64.858  | .988    | 7  |
| 54      | .571    | .571    | 63.657  | .988    | 6  |
| 55      | .01600  | .01600  | 62.499  | .99987  | 5  |
| 56      | .629    | .629    | 61.383  | .987    | 4  |
| 57      | .658    | .658    | 60.306  | .986    | 3  |
| 58      | .687    | .687    | 59.266  | .986    | 2  |
| 59      | .716    | .716    | 58.261  | .985    | 1  |
| 60      | .01745  | .01746  | 57.290  | .99985  | 0  |
|         |         |         |         |         | '  |
| N. Cos. |         | N. Cot. | N. Tan. | N. Sin. |    |

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| '       | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|---------|---------|---------|---------|---------|----|
| 0       | .01745  | .01746  | 57.290  | .99985  | 60 |
| 1       | .774    | .775    | 56.351  | .984    | 59 |
| 2       | .803    | .804    | 55.442  | .984    | 58 |
| 3       | .832    | .833    | 54.561  | .983    | 57 |
| 4       | .862    | .862    | 53.709  | .983    | 56 |
| 5       | .01891  | .01891  | 52.882  | .99982  | 55 |
| 6       | .920    | .920    | 52.081  | .982    | 54 |
| 7       | .949    | .949    | 51.303  | .981    | 53 |
| 8       | .01978  | .01978  | 50.549  | .980    | 52 |
| 9       | .02007  | .02007  | 49.816  | .980    | 51 |
| 10      | .02036  | .02036  | 49.104  | .99979  | 50 |
| 11      | .065    | .066    | 48.412  | .979    | 49 |
| 12      | .094    | .095    | 47.740  | .978    | 48 |
| 13      | .123    | .124    | 47.085  | .977    | 47 |
| 14      | .152    | .153    | 46.449  | .977    | 46 |
| 15      | .02181  | .02182  | 45.829  | .99976  | 45 |
| 16      | .211    | .211    | 45.226  | .976    | 44 |
| 17      | .240    | .240    | 44.639  | .975    | 43 |
| 18      | .269    | .269    | 44.066  | .974    | 42 |
| 19      | .298    | .298    | 43.508  | .974    | 41 |
| 20      | .02327  | .02328  | 42.964  | .99973  | 40 |
| 21      | .356    | .357    | 42.433  | .972    | 39 |
| 22      | .385    | .386    | 41.916  | .972    | 38 |
| 23      | .414    | .415    | 41.411  | .971    | 37 |
| 24      | .443    | .444    | 40.917  | .970    | 36 |
| 25      | .02473  | .02473  | 40.436  | .99969  | 35 |
| 26      | .501    | .502    | 39.965  | .969    | 34 |
| 27      | .530    | .531    | 39.506  | .968    | 33 |
| 28      | .560    | .560    | 39.057  | .967    | 32 |
| 29      | .589    | .589    | 38.618  | .966    | 31 |
| 30      | .02618  | .02619  | 38.188  | .99966  | 30 |
| 31      | .647    | .648    | 37.769  | .965    | 29 |
| 32      | .676    | .677    | 37.358  | .964    | 28 |
| 33      | .705    | .706    | 36.956  | .963    | 27 |
| 34      | .734    | .735    | 36.563  | .963    | 26 |
| 35      | .02763  | .02764  | 36.178  | .99962  | 25 |
| 36      | .792    | .793    | 35.801  | .961    | 24 |
| 37      | .821    | .822    | 35.431  | .960    | 23 |
| 38      | .850    | .851    | 35.070  | .959    | 22 |
| 39      | .879    | .881    | 34.715  | .959    | 21 |
| 40      | .02908  | .02910  | 34.368  | .99958  | 20 |
| 41      | .938    | .939    | 34.027  | .957    | 19 |
| 42      | .967    | .968    | 33.694  | .956    | 18 |
| 43      | .02996  | .02997  | 33.366  | .955    | 17 |
| 44      | .03025  | .03026  | 33.045  | .954    | 16 |
| 45      | .03054  | .03055  | 32.730  | .99953  | 15 |
| 46      | .083    | .084    | 32.421  | .952    | 14 |
| 47      | .112    | .114    | 32.118  | .952    | 13 |
| 48      | .141    | .143    | 31.821  | .951    | 12 |
| 49      | .170    | .172    | 31.528  | .950    | 11 |
| 50      | .03199  | .03201  | 31.242  | .99949  | 10 |
| 51      | .228    | .230    | 30.960  | .948    | 9  |
| 52      | .257    | .259    | 30.683  | .947    | 8  |
| 53      | .286    | .288    | 30.412  | .946    | 7  |
| 54      | .316    | .317    | 30.145  | .945    | 6  |
| 55      | .03345  | .03346  | 29.882  | .99944  | 5  |
| 56      | .374    | .376    | 29.624  | .943    | 4  |
| 57      | .403    | .405    | 29.371  | .942    | 3  |
| 58      | .432    | .434    | 29.122  | .941    | 2  |
| 59      | .461    | .463    | 28.877  | .940    | 1  |
| 60      | .03490  | .03492  | 28.636  | .99939  | 0  |
|         |         |         |         |         | '  |
| N. Cos. |         | N. Cot. | N. Tan. | N. Sin. |    |

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|                                 | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|---------------------------------|---------|---------|---------|---------|----|
| 0                               | .03490  | .03492  | 28.636  | .99939  | 60 |
| 1                               | 519     | 521     | .399    | 938     | 59 |
| 2                               | 548     | 550     | 28.166  | 937     | 58 |
| 3                               | 577     | 579     | 27.937  | 936     | 57 |
| 4                               | 606     | 609     | .712    | 935     | 56 |
| 5                               | .03635  | .03638  | 27.490  | .99934  | 55 |
| 6                               | 604     | 607     | .271    | 933     | 54 |
| 7                               | 693     | 696     | 27.057  | 932     | 53 |
| 8                               | 723     | 725     | 26.845  | 931     | 52 |
| 9                               | 752     | 754     | .637    | 930     | 51 |
| 10                              | .03781  | .03783  | 26.432  | .99929  | 50 |
| 11                              | 810     | 812     | .230    | 927     | 49 |
| 12                              | 839     | 842     | 26.031  | 926     | 48 |
| 13                              | 868     | 871     | 25.835  | 925     | 47 |
| 14                              | 897     | 900     | .642    | 924     | 46 |
| 15                              | .03926  | .03929  | 25.452  | .99923  | 45 |
| 16                              | 955     | 958     | .264    | 922     | 44 |
| 17                              | .03984  | .03987  | 25.080  | 921     | 43 |
| 18                              | .04013  | .04016  | 24.898  | 919     | 42 |
| 19                              | 042     | 046     | .719    | 918     | 41 |
| 20                              | .04071  | .04075  | 24.542  | .99917  | 40 |
| 21                              | 100     | 104     | .368    | 916     | 39 |
| 22                              | 129     | 133     | .196    | 915     | 38 |
| 23                              | 159     | 162     | 24.026  | 913     | 37 |
| 24                              | 188     | 191     | 23.859  | 912     | 36 |
| 25                              | .04217  | .04220  | 23.695  | .99911  | 35 |
| 26                              | 246     | 250     | .532    | 910     | 34 |
| 27                              | 275     | 279     | .372    | 909     | 33 |
| 28                              | 304     | 308     | .214    | 907     | 32 |
| 29                              | 333     | 337     | 23.058  | 906     | 31 |
| 30                              | .04362  | .04366  | 22.904  | .99905  | 30 |
| 31                              | 391     | 395     | .752    | 904     | 29 |
| 32                              | 420     | 424     | .602    | 902     | 28 |
| 33                              | 449     | 454     | .454    | 901     | 27 |
| 34                              | 478     | 483     | .308    | 900     | 26 |
| 35                              | .04507  | .04512  | 22.164  | .99898  | 25 |
| 36                              | 536     | 541     | 22.022  | 897     | 24 |
| 37                              | 565     | 570     | 21.881  | 896     | 23 |
| 38                              | 594     | 599     | .743    | 894     | 22 |
| 39                              | 623     | 628     | .606    | 893     | 21 |
| 40                              | .04653  | .04658  | 21.470  | .99892  | 20 |
| 41                              | 682     | 687     | .337    | 890     | 19 |
| 42                              | 711     | 716     | .205    | 889     | 18 |
| 43                              | 740     | 745     | 21.075  | 888     | 17 |
| 44                              | 769     | 774     | 20.946  | 886     | 16 |
| 45                              | .04798  | .04803  | 20.819  | .99885  | 15 |
| 46                              | 827     | 833     | .693    | 883     | 14 |
| 47                              | 856     | 862     | .569    | 882     | 13 |
| 48                              | 885     | 891     | .446    | 881     | 12 |
| 49                              | 914     | 920     | .325    | 879     | 11 |
| 50                              | .04943  | .04949  | 20.206  | .99878  | 10 |
| 51                              | .04972  | .04978  | 20.087  | 876     | 9  |
| 52                              | .05001  | .05007  | 19.970  | 875     | 8  |
| 53                              | 030     | 037     | .855    | 873     | 7  |
| 54                              | 059     | 066     | .740    | 872     | 6  |
| 55                              | .05088  | .05095  | 19.627  | .99870  | 5  |
| 56                              | 117     | 124     | .516    | 869     | 4  |
| 57                              | 146     | 153     | .405    | 867     | 3  |
| 58                              | 175     | 182     | .296    | 866     | 2  |
| 59                              | 205     | 212     | .188    | 864     | 1  |
| 60                              | .05234  | .05241  | 19.081  | .99863  | 0  |
| N. Cos. N. Cot. N. Tan. N. Sin. |         |         |         |         |    |

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|                                 | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|---------------------------------|---------|---------|---------|---------|----|
| 0                               | .05234  | .05241  | 19.081  | .99863  | 60 |
| 1                               | 263     | 270     | 18.976  | 861     | 59 |
| 2                               | 292     | 299     | .871    | 860     | 58 |
| 3                               | 321     | 328     | .768    | 858     | 57 |
| 4                               | 350     | 357     | .666    | 857     | 56 |
| 5                               | .05379  | .05387  | 18.564  | .99855  | 55 |
| 6                               | 408     | 416     | .464    | 854     | 54 |
| 7                               | 437     | 445     | .366    | 852     | 53 |
| 8                               | 466     | 474     | .268    | 851     | 52 |
| 9                               | 495     | 503     | .171    | 850     | 51 |
| 10                              | .05524  | .05533  | 18.075  | .99847  | 50 |
| 11                              | 553     | 562     | 17.980  | 840     | 49 |
| 12                              | 582     | 591     | .886    | 844     | 48 |
| 13                              | 611     | 620     | .793    | 842     | 47 |
| 14                              | 640     | 649     | .702    | 841     | 46 |
| 15                              | .05669  | .05678  | 17.611  | .99839  | 45 |
| 16                              | 668     | 708     | .521    | 838     | 44 |
| 17                              | 727     | 737     | .431    | 836     | 43 |
| 18                              | 756     | 766     | .343    | 834     | 42 |
| 19                              | 785     | 795     | .256    | 833     | 41 |
| 20                              | .05814  | .05824  | 17.169  | .99831  | 40 |
| 21                              | 844     | 854     | 17.084  | 829     | 39 |
| 22                              | 873     | 883     | 16.999  | 827     | 38 |
| 23                              | 902     | 912     | .915    | 826     | 37 |
| 24                              | 931     | 941     | .832    | 824     | 36 |
| 25                              | .05960  | .05970  | 16.750  | .99822  | 35 |
| 26                              | .05989  | .05999  | .668    | 821     | 34 |
| 27                              | .06018  | .06029  | .587    | 819     | 33 |
| 28                              | 047     | 058     | .507    | 817     | 32 |
| 29                              | 076     | 087     | .428    | 815     | 31 |
| 30                              | .06105  | .06116  | 16.350  | .99813  | 30 |
| 31                              | 134     | 145     | .272    | 812     | 29 |
| 32                              | 163     | 175     | .195    | 810     | 28 |
| 33                              | 192     | 204     | .119    | 808     | 27 |
| 34                              | 221     | 233     | 16.043  | 806     | 26 |
| 35                              | .06250  | .06262  | 15.969  | .99804  | 25 |
| 36                              | 279     | 291     | .895    | 803     | 24 |
| 37                              | 308     | 321     | .821    | 801     | 23 |
| 38                              | 337     | 350     | .748    | 799     | 22 |
| 39                              | 366     | 379     | .676    | 797     | 21 |
| 40                              | .06395  | .06408  | 15.605  | .99795  | 20 |
| 41                              | 424     | 438     | .534    | 793     | 19 |
| 42                              | 453     | 467     | .464    | 792     | 18 |
| 43                              | 482     | 496     | .394    | 790     | 17 |
| 44                              | 511     | 525     | .325    | 788     | 16 |
| 45                              | .06540  | .06554  | 15.257  | .99786  | 15 |
| 46                              | 569     | 584     | .189    | 784     | 14 |
| 47                              | 598     | 613     | .122    | 782     | 13 |
| 48                              | 627     | 642     | 15.056  | 780     | 12 |
| 49                              | 656     | 671     | 14.990  | 778     | 11 |
| 50                              | .06685  | .06700  | 14.924  | .99776  | 10 |
| 51                              | 714     | 730     | .860    | 774     | 9  |
| 52                              | 743     | 759     | .795    | 772     | 8  |
| 53                              | 773     | 788     | .732    | 770     | 7  |
| 54                              | 802     | 817     | .669    | 768     | 6  |
| 55                              | .06831  | .06847  | 14.606  | .99766  | 5  |
| 56                              | 860     | 876     | .544    | 764     | 4  |
| 57                              | 889     | 905     | .482    | 762     | 3  |
| 58                              | 918     | 934     | .421    | 760     | 2  |
| 59                              | 947     | 963     | .361    | 758     | 1  |
| 60                              | .06976  | .06993  | 14.301  | .99756  | 0  |
| N. Cos. N. Cot. N. Tan. N. Sin. |         |         |         |         |    |

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|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .06976  | .06993  | 14.301  | .99756  | 60 |
| 1  | .07005  | .07022  | .241    | 754     | 59 |
| 2  | .034    | .051    | .182    | 752     | 58 |
| 3  | .063    | .080    | .124    | 750     | 57 |
| 4  | .092    | .110    | .065    | 748     | 56 |
| 5  | .07121  | .07139  | 14.008  | .99746  | 55 |
| 6  | .130    | .168    | 13.951  | 744     | 54 |
| 7  | .179    | .197    | .894    | 742     | 53 |
| 8  | .208    | .227    | .838    | 740     | 52 |
| 9  | .237    | .256    | .782    | 738     | 51 |
| 10 | .07266  | .07285  | 13.727  | .99736  | 50 |
| 11 | .295    | .314    | .672    | 734     | 49 |
| 12 | .324    | .344    | .617    | 731     | 48 |
| 13 | .353    | .373    | .563    | 729     | 47 |
| 14 | .382    | .402    | .510    | 727     | 46 |
| 15 | .07411  | .07431  | 13.457  | .99725  | 45 |
| 16 | .440    | .461    | .404    | 723     | 44 |
| 17 | .469    | .490    | .352    | 721     | 43 |
| 18 | .498    | .519    | .300    | 719     | 42 |
| 19 | .527    | .548    | .248    | 716     | 41 |
| 20 | .07556  | .07578  | 13.197  | .99714  | 40 |
| 21 | .585    | .607    | .146    | 712     | 39 |
| 22 | .614    | .636    | .096    | 710     | 38 |
| 23 | .643    | .665    | 13.046  | 708     | 37 |
| 24 | .672    | .695    | 12.996  | 705     | 36 |
| 25 | .07701  | .07724  | 12.947  | .99703  | 35 |
| 26 | .730    | .753    | .898    | 701     | 34 |
| 27 | .759    | .782    | .850    | 699     | 33 |
| 28 | .788    | .812    | .801    | 696     | 32 |
| 29 | .817    | .841    | .754    | 694     | 31 |
| 30 | .07846  | .07870  | 12.706  | .99692  | 30 |
| 31 | .875    | .899    | .659    | 689     | 29 |
| 32 | .904    | .929    | .612    | 687     | 28 |
| 33 | .933    | .958    | .566    | 685     | 27 |
| 34 | .962    | .07987  | .520    | 683     | 26 |
| 35 | .07991  | .08017  | 12.474  | .99680  | 25 |
| 36 | .08020  | .046    | .429    | 678     | 24 |
| 37 | .049    | .075    | .384    | 676     | 23 |
| 38 | .078    | .104    | .339    | 673     | 22 |
| 39 | .107    | .134    | .293    | 671     | 21 |
| 40 | .08136  | .08163  | 12.251  | .99668  | 20 |
| 41 | .165    | .192    | .207    | 666     | 19 |
| 42 | .194    | .221    | .163    | 664     | 18 |
| 43 | .223    | .251    | .120    | 661     | 17 |
| 44 | .252    | .280    | .077    | 659     | 16 |
| 45 | .08281  | .08309  | 12.035  | .99657  | 15 |
| 46 | .310    | .339    | 11.992  | 654     | 14 |
| 47 | .339    | .368    | .950    | 652     | 13 |
| 48 | .368    | .397    | .909    | 649     | 12 |
| 49 | .397    | .427    | .867    | 647     | 11 |
| 50 | .08426  | .08456  | 11.826  | .99644  | 10 |
| 51 | .455    | .485    | .785    | 642     | 9  |
| 52 | .484    | .514    | .743    | 639     | 8  |
| 53 | .513    | .544    | .705    | 637     | 7  |
| 54 | .542    | .573    | .664    | 635     | 6  |
| 55 | .08571  | .08602  | 11.625  | .99632  | 5  |
| 56 | .600    | .632    | .585    | 630     | 4  |
| 57 | .629    | .661    | .546    | 627     | 3  |
| 58 | .658    | .690    | .507    | 625     | 2  |
| 59 | .687    | .720    | .468    | 622     | 1  |
| 60 | .08716  | .08749  | 11.430  | .99619  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

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|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .08716  | .08749  | 11.430  | .99619  | 60 |
| 1  | .745    | .778    | .392    | 617     | 59 |
| 2  | .774    | .807    | .354    | 614     | 58 |
| 3  | .803    | .837    | .316    | 612     | 57 |
| 4  | .831    | .866    | .279    | 609     | 56 |
| 5  | .08860  | .08895  | 11.242  | .99607  | 55 |
| 6  | .889    | .925    | .205    | 604     | 54 |
| 7  | .918    | .954    | .168    | 602     | 53 |
| 8  | .947    | .08983  | .132    | 599     | 52 |
| 9  | .08976  | .09013  | .095    | 596     | 51 |
| 10 | .09005  | .09042  | 11.059  | .99594  | 50 |
| 11 | .034    | .071    | 11.024  | 591     | 49 |
| 12 | .063    | .101    | 10.988  | 588     | 48 |
| 13 | .092    | .130    | .953    | 586     | 47 |
| 14 | .121    | .159    | .918    | 583     | 46 |
| 15 | .09150  | .09189  | 10.883  | .99580  | 45 |
| 16 | .179    | .218    | .848    | 578     | 44 |
| 17 | .208    | .247    | .814    | 575     | 43 |
| 18 | .237    | .277    | .780    | 572     | 42 |
| 19 | .266    | .306    | .746    | 570     | 41 |
| 20 | .09295  | .09335  | 10.712  | .99567  | 40 |
| 21 | .324    | .365    | .678    | 564     | 39 |
| 22 | .353    | .394    | .645    | 562     | 38 |
| 23 | .382    | .423    | .612    | 559     | 37 |
| 24 | .411    | .453    | .579    | 556     | 36 |
| 25 | .09440  | .09482  | 10.546  | .99553  | 35 |
| 26 | .469    | .511    | .514    | 551     | 34 |
| 27 | .498    | .541    | .481    | 548     | 33 |
| 28 | .527    | .570    | .449    | 545     | 32 |
| 29 | .556    | .600    | .417    | 542     | 31 |
| 30 | .09585  | .09629  | 10.385  | .99540  | 30 |
| 31 | .614    | .658    | .354    | 537     | 29 |
| 32 | .642    | .688    | .322    | 534     | 28 |
| 33 | .671    | .717    | .291    | 531     | 27 |
| 34 | .700    | .746    | .260    | 528     | 26 |
| 35 | .09729  | .09776  | 10.229  | .99526  | 25 |
| 36 | .758    | .805    | .199    | 523     | 24 |
| 37 | .787    | .834    | .168    | 520     | 23 |
| 38 | .816    | .864    | .138    | 517     | 22 |
| 39 | .845    | .893    | .108    | 514     | 21 |
| 40 | .09874  | .09923  | 10.078  | .99511  | 20 |
| 41 | .903    | .952    | .048    | 508     | 19 |
| 42 | .932    | .09981  | 10.019  | 506     | 18 |
| 43 | .961    | .10011  | 9.9893  | 503     | 17 |
| 44 | .09990  | .040    | .9601   | 500     | 16 |
| 45 | .10019  | .10069  | 9.9310  | .99497  | 15 |
| 46 | .048    | .099    | .9021   | 494     | 14 |
| 47 | .077    | .128    | .8734   | 491     | 13 |
| 48 | .106    | .158    | .8448   | 488     | 12 |
| 49 | .135    | .187    | .8164   | 485     | 11 |
| 50 | .10164  | .10216  | 9.7882  | .99482  | 10 |
| 51 | .192    | .246    | .7601   | 479     | 9  |
| 52 | .221    | .275    | .7322   | 476     | 8  |
| 53 | .250    | .305    | .7044   | 473     | 7  |
| 54 | .279    | .334    | .6768   | 470     | 6  |
| 55 | .10308  | .10363  | 9.6493  | .99467  | 5  |
| 56 | .337    | .393    | .6220   | 464     | 4  |
| 57 | .366    | .422    | .5949   | 461     | 3  |
| 58 | .395    | .452    | .5679   | 458     | 2  |
| 59 | .424    | .481    | .5411   | 455     | 1  |
| 60 | .10453  | .10510  | 9.5144  | .99452  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

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|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .10453  | .10510  | 9.5144  | .99452  | 60 |
| 1  | 482     | 540     | .4878   | 449     | 59 |
| 2  | 511     | 569     | .4614   | 446     | 58 |
| 3  | 540     | 599     | .4352   | 443     | 57 |
| 4  | 569     | 628     | .4090   | 440     | 56 |
| 5  | .10597  | .10657  | 9.3831  | .99437  | 55 |
| 6  | 626     | 687     | .3572   | 434     | 54 |
| 7  | 655     | 716     | .3315   | 431     | 53 |
| 8  | 684     | 746     | .3060   | 428     | 52 |
| 9  | 713     | 775     | .2806   | 424     | 51 |
| 10 | .10742  | .10805  | 9.2553  | .99421  | 50 |
| 11 | 771     | 834     | .2302   | 418     | 49 |
| 12 | 800     | 863     | .2052   | 415     | 48 |
| 13 | 829     | 893     | .1803   | 412     | 47 |
| 14 | 858     | 922     | .1555   | 409     | 46 |
| 15 | .10887  | .10952  | 9.1309  | .99406  | 45 |
| 16 | 916     | .10981  | .1065   | 402     | 44 |
| 17 | 945     | .11011  | .0821   | 399     | 43 |
| 18 | .10973  | .040    | .0579   | 396     | 42 |
| 19 | .11002  | .070    | .0338   | 393     | 41 |
| 20 | .11031  | .11099  | 9.0098  | .99390  | 40 |
| 21 | 060     | 128     | .89860  | 386     | 39 |
| 22 | 089     | 158     | .9623   | 383     | 38 |
| 23 | 118     | 187     | .9387   | 380     | 37 |
| 24 | 147     | 217     | .9152   | 377     | 36 |
| 25 | .11176  | .11240  | 8.8919  | .99374  | 35 |
| 26 | 205     | 276     | .8686   | 370     | 34 |
| 27 | 234     | 305     | .8455   | 367     | 33 |
| 28 | 263     | 335     | .8225   | 364     | 32 |
| 29 | 291     | 364     | .7996   | 360     | 31 |
| 30 | .11320  | .11394  | 8.7769  | .99357  | 30 |
| 31 | 349     | 423     | .7542   | 354     | 29 |
| 32 | 378     | 452     | .7317   | 351     | 28 |
| 33 | 407     | 482     | .7093   | 347     | 27 |
| 34 | 436     | 511     | .6870   | 344     | 26 |
| 35 | .11465  | .11541  | 8.6648  | .99341  | 25 |
| 36 | 494     | 570     | .6627   | 337     | 24 |
| 37 | 523     | 600     | .6408   | 334     | 23 |
| 38 | 552     | 629     | .6189   | 331     | 22 |
| 39 | 580     | 659     | .5972   | 327     | 21 |
| 40 | .11609  | .11688  | 8.5555  | .99324  | 20 |
| 41 | 638     | 718     | .5740   | 320     | 19 |
| 42 | 667     | 747     | .5526   | 317     | 18 |
| 43 | 696     | 777     | .5313   | 314     | 17 |
| 44 | 725     | 806     | .5101   | 310     | 16 |
| 45 | .11754  | .11836  | 8.4490  | .99307  | 15 |
| 46 | 783     | 865     | .4880   | 303     | 14 |
| 47 | 812     | 895     | .4671   | 300     | 13 |
| 48 | 840     | 924     | .4463   | 297     | 12 |
| 49 | 869     | 954     | .4256   | 293     | 11 |
| 50 | .11898  | .11983  | 8.3450  | .99290  | 10 |
| 51 | 927     | .12013  | .4045   | 286     | 9  |
| 52 | 956     | .042    | .3837   | 283     | 8  |
| 53 | .11985  | .072    | .3630   | 279     | 7  |
| 54 | .12014  | .101    | .3423   | 276     | 6  |
| 55 | .12043  | .12131  | 8.2434  | .99272  | 5  |
| 56 | 071     | 160     | .3216   | 269     | 4  |
| 57 | 100     | 190     | .3010   | 265     | 3  |
| 58 | 129     | 219     | .2805   | 262     | 2  |
| 59 | 158     | 249     | .2600   | 258     | 1  |
| 60 | .12187  | .12278  | 8.1443  | .99255  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .12187  | .12278  | 8.1443  | .99255  | 60 |
| 1  | 216     | 308     | .1248   | 251     | 59 |
| 2  | 245     | 338     | .1054   | 248     | 58 |
| 3  | 274     | 367     | .0860   | 244     | 57 |
| 4  | 302     | 397     | .0667   | 240     | 56 |
| 5  | .12331  | .12426  | 8.0476  | .99237  | 55 |
| 6  | 360     | 456     | .0475   | 233     | 54 |
| 7  | 389     | 485     | .0285   | 230     | 53 |
| 8  | 418     | 515     | .0095   | 226     | 52 |
| 9  | 447     | 544     | .9718   | 222     | 51 |
| 10 | .12476  | .12574  | 7.9530  | .99219  | 50 |
| 11 | 504     | 603     | .9344   | 215     | 49 |
| 12 | 533     | 633     | .9158   | 211     | 48 |
| 13 | 562     | 662     | .8973   | 208     | 47 |
| 14 | 591     | 692     | .8789   | 204     | 46 |
| 15 | .12620  | .12722  | 7.8606  | .99200  | 45 |
| 16 | 649     | 751     | .8424   | 197     | 44 |
| 17 | 678     | 781     | .8243   | 193     | 43 |
| 18 | 706     | 810     | .8062   | 189     | 42 |
| 19 | 735     | 840     | .7882   | 186     | 41 |
| 20 | .12764  | .12869  | 7.7704  | .99182  | 40 |
| 21 | 793     | 899     | .7525   | 178     | 39 |
| 22 | 822     | 929     | .7348   | 175     | 38 |
| 23 | 851     | 958     | .7171   | 171     | 37 |
| 24 | 880     | .12988  | .6996   | 167     | 36 |
| 25 | .12908  | .13017  | 7.6821  | .99163  | 35 |
| 26 | 937     | 047     | .6647   | 160     | 34 |
| 27 | 966     | 076     | .6473   | 156     | 33 |
| 28 | .12995  | 106     | .6301   | 152     | 32 |
| 29 | .13024  | 136     | .6129   | 148     | 31 |
| 30 | .13053  | .13165  | 7.5958  | .99144  | 30 |
| 31 | 081     | 195     | .5787   | 141     | 29 |
| 32 | 110     | 224     | .5618   | 137     | 28 |
| 33 | 139     | 254     | .5449   | 133     | 27 |
| 34 | 168     | 284     | .5281   | 129     | 26 |
| 35 | .13197  | .13313  | 7.5113  | .99125  | 25 |
| 36 | 226     | 343     | .4947   | 122     | 24 |
| 37 | 254     | 372     | .4781   | 118     | 23 |
| 38 | 283     | 402     | .4615   | 114     | 22 |
| 39 | 312     | 432     | .4451   | 110     | 21 |
| 40 | .13341  | .13461  | 7.4287  | .99106  | 20 |
| 41 | 370     | 491     | .4124   | 102     | 19 |
| 42 | 399     | 521     | .3962   | 098     | 18 |
| 43 | 427     | 550     | .3800   | 094     | 17 |
| 44 | 456     | 580     | .3639   | 091     | 16 |
| 45 | .13485  | .13609  | 7.3479  | .99087  | 15 |
| 46 | 514     | 639     | .3319   | 083     | 14 |
| 47 | 543     | 669     | .3160   | 079     | 13 |
| 48 | 572     | 698     | .3002   | 075     | 12 |
| 49 | 600     | 728     | .2844   | 071     | 11 |
| 50 | .13629  | .13758  | 7.2687  | .99067  | 10 |
| 51 | 658     | 787     | .2531   | 063     | 9  |
| 52 | 687     | 817     | .2375   | 059     | 8  |
| 53 | 716     | 846     | .2220   | 055     | 7  |
| 54 | 744     | 876     | .2066   | 051     | 6  |
| 55 | .13773  | .13906  | 7.1912  | .99047  | 5  |
| 56 | 802     | 935     | .1759   | 043     | 4  |
| 57 | 831     | 965     | .1607   | 039     | 3  |
| 58 | 860     | .13995  | .1455   | 035     | 2  |
| 59 | 889     | .14024  | .1304   | 031     | 1  |
| 60 | .13917  | .14054  | 7.1154  | .99027  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .13917  | .14054  | 7.1154  | .99027  | 60 |
| 1  | 946     | 084     | .1004   | 023     | 59 |
| 2  | .13975  | 113     | .0855   | 019     | 58 |
| 3  | .14004  | 143     | .0706   | 015     | 57 |
| 4  | 033     | 173     | .0558   | 011     | 56 |
| 5  | .14061  | .14202  | 7.0410  | .99006  | 55 |
| 6  | 090     | 232     | .0264   | .99002  | 54 |
| 7  | 119     | 262     | 7.0117  | .98998  | 53 |
| 8  | 148     | 291     | 6.9972  | .994    | 52 |
| 9  | 177     | 321     | .9827   | .990    | 51 |
| 10 | .14205  | .14351  | 6.9682  | .98986  | 50 |
| 11 | 234     | 351     | .9538   | .982    | 49 |
| 12 | 263     | 410     | .9395   | .978    | 48 |
| 13 | 292     | 440     | .9252   | .973    | 47 |
| 14 | 320     | 470     | .9110   | .969    | 46 |
| 15 | .14349  | .14499  | 6.8969  | .98965  | 45 |
| 16 | 378     | 529     | .8828   | .961    | 44 |
| 17 | 407     | 559     | .8687   | .957    | 43 |
| 18 | 436     | 588     | .8548   | .953    | 42 |
| 19 | 464     | 618     | .8408   | .948    | 41 |
| 20 | .14493  | .14648  | 6.8269  | .98944  | 40 |
| 21 | 522     | 678     | .8131   | .940    | 39 |
| 22 | 551     | 707     | .7994   | .936    | 38 |
| 23 | 580     | 737     | .7856   | .931    | 37 |
| 24 | 608     | 767     | .7720   | .927    | 36 |
| 25 | .14637  | .14796  | 6.7584  | .98923  | 35 |
| 26 | 666     | 826     | .7448   | .919    | 34 |
| 27 | 695     | 856     | .7313   | .914    | 33 |
| 28 | 723     | 886     | .7179   | .910    | 32 |
| 29 | 752     | 915     | .7045   | .906    | 31 |
| 30 | .14781  | .14945  | 6.6912  | .98902  | 30 |
| 31 | 810     | .14975  | .6779   | .897    | 29 |
| 32 | 838     | .15005  | .6646   | .893    | 28 |
| 33 | 867     | 034     | .6514   | .889    | 27 |
| 34 | 896     | 064     | .6383   | .884    | 26 |
| 35 | .14923  | .15094  | 6.6252  | .98880  | 25 |
| 36 | 954     | 124     | .6122   | .876    | 24 |
| 37 | .14982  | 153     | .5992   | .871    | 23 |
| 38 | .15011  | 183     | .5863   | .867    | 22 |
| 39 | 040     | 213     | .5734   | .863    | 21 |
| 40 | .15069  | .15243  | 6.5606  | .98858  | 20 |
| 41 | 097     | 272     | .5478   | .854    | 19 |
| 42 | 126     | 302     | .5350   | .849    | 18 |
| 43 | 155     | 332     | .5223   | .845    | 17 |
| 44 | 184     | 362     | .5097   | .841    | 16 |
| 45 | .15212  | .15391  | 6.4971  | .98836  | 15 |
| 46 | 241     | 421     | .4846   | .832    | 14 |
| 47 | 270     | 451     | .4721   | .827    | 13 |
| 48 | 299     | 481     | .4596   | .823    | 12 |
| 49 | 327     | 511     | .4472   | .818    | 11 |
| 50 | .15356  | .15540  | 6.4348  | .98814  | 10 |
| 51 | 385     | 570     | .4225   | .809    | 9  |
| 52 | 414     | 600     | .4103   | .805    | 8  |
| 53 | 442     | 630     | .3980   | .800    | 7  |
| 54 | 471     | 660     | .3859   | .796    | 6  |
| 55 | .15500  | .15689  | 6.3737  | .98791  | 5  |
| 56 | 529     | 719     | .3617   | .787    | 4  |
| 57 | 557     | 749     | .3496   | .782    | 3  |
| 58 | 586     | 779     | .3376   | .778    | 2  |
| 59 | 615     | 809     | .3257   | .773    | 1  |
| 60 | .15643  | .15838  | 6.3138  | .98769  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

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|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .15643  | .15838  | 6.3138  | .98769  | 60 |
| 1  | 672     | 868     | .3019   | .764    | 59 |
| 2  | 701     | 898     | .2901   | .760    | 58 |
| 3  | 730     | 928     | .2783   | .755    | 57 |
| 4  | 758     | 958     | .2666   | .751    | 56 |
| 5  | .15787  | .15988  | 6.2549  | .98764  | 55 |
| 6  | 816     | .16017  | .2432   | .741    | 54 |
| 7  | 845     | 047     | .2316   | .737    | 53 |
| 8  | 873     | 077     | .2200   | .732    | 52 |
| 9  | 902     | 107     | .2085   | .728    | 51 |
| 10 | .15931  | .16137  | 6.1970  | .98723  | 50 |
| 11 | 959     | 167     | .1856   | .718    | 49 |
| 12 | .15988  | 196     | .1742   | .714    | 48 |
| 13 | .16017  | 226     | .1628   | .709    | 47 |
| 14 | 046     | 256     | .1515   | .704    | 46 |
| 15 | .16074  | .16286  | 6.1402  | .98700  | 45 |
| 16 | 103     | 316     | .1290   | .695    | 44 |
| 17 | 132     | 346     | .1178   | .690    | 43 |
| 18 | 160     | 376     | .1066   | .686    | 42 |
| 19 | 189     | 405     | .0955   | .681    | 41 |
| 20 | .16218  | .16435  | 6.0844  | .98676  | 40 |
| 21 | 246     | 465     | .0734   | .671    | 39 |
| 22 | 275     | 495     | .0624   | .667    | 38 |
| 23 | 304     | 525     | .0514   | .662    | 37 |
| 24 | 333     | 555     | .0405   | .657    | 36 |
| 25 | .16361  | .16585  | 6.0296  | .98652  | 35 |
| 26 | 390     | 615     | .0188   | .648    | 34 |
| 27 | 419     | 645     | 6.0080  | .643    | 33 |
| 28 | 447     | 674     | 5.9972  | .638    | 32 |
| 29 | 476     | 704     | .9863   | .633    | 31 |
| 30 | .16505  | .16734  | 5.9758  | .98629  | 30 |
| 31 | 533     | 764     | .9651   | .624    | 29 |
| 32 | 562     | 794     | .9545   | .619    | 28 |
| 33 | 591     | 824     | .9439   | .614    | 27 |
| 34 | 620     | 854     | .9333   | .609    | 26 |
| 35 | .16648  | .16884  | 5.9228  | .98604  | 25 |
| 36 | 677     | 914     | .9124   | .600    | 24 |
| 37 | 706     | 944     | .9019   | .595    | 23 |
| 38 | 734     | .16974  | .8915   | .590    | 22 |
| 39 | 763     | .17004  | .8811   | .585    | 21 |
| 40 | .16792  | .17033  | 5.8708  | .98580  | 20 |
| 41 | 820     | 063     | .8605   | .575    | 19 |
| 42 | 849     | 093     | .8502   | .570    | 18 |
| 43 | 878     | 123     | .8400   | .565    | 17 |
| 44 | 906     | 153     | .8298   | .561    | 16 |
| 45 | .16935  | .17183  | 5.8197  | .98556  | 15 |
| 46 | 904     | 213     | .8095   | .551    | 14 |
| 47 | .16992  | 243     | .7994   | .546    | 13 |
| 48 | .17021  | 273     | .7894   | .541    | 12 |
| 49 | 050     | 303     | .7794   | .536    | 11 |
| 50 | .17078  | .17333  | 5.7694  | .98531  | 10 |
| 51 | 107     | 363     | .7594   | .526    | 9  |
| 52 | 136     | 393     | .7495   | .521    | 8  |
| 53 | 164     | 423     | .7396   | .516    | 7  |
| 54 | 193     | 453     | .7297   | .511    | 6  |
| 55 | .17222  | .17483  | 5.7199  | .98506  | 5  |
| 56 | 250     | 513     | .7101   | .501    | 4  |
| 57 | 279     | 543     | .7004   | .496    | 3  |
| 58 | 308     | 573     | .6906   | .491    | 2  |
| 59 | 336     | 603     | .6809   | .486    | 1  |
| 60 | .17365  | .17633  | 5.6713  | .98481  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

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|                                 | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|---------------------------------|---------|---------|---------|---------|----|
| 0                               | .17363  | .17633  | 5.6713  | .98481  | 60 |
| 1                               | 393     | 663     | .6617   | 476     | 59 |
| 2                               | 422     | 693     | .6521   | 471     | 58 |
| 3                               | 451     | 723     | .6425   | 466     | 57 |
| 4                               | 479     | 753     | .6329   | 461     | 56 |
| 5                               | .17508  | .17783  | 5.6234  | .98455  | 55 |
| 6                               | 537     | 813     | .6140   | 450     | 54 |
| 7                               | 565     | 843     | .6045   | 445     | 53 |
| 8                               | 594     | 873     | .5951   | 440     | 52 |
| 9                               | 623     | 903     | .5857   | 435     | 51 |
| 10                              | .17651  | .17933  | 5.5764  | .98430  | 50 |
| 11                              | 680     | 963     | .5671   | 425     | 49 |
| 12                              | 708     | .17993  | .5578   | 420     | 48 |
| 13                              | 737     | .18023  | .5485   | 414     | 47 |
| 14                              | 766     | 053     | .5393   | 409     | 46 |
| 15                              | .17794  | .18083  | 5.5301  | .98404  | 45 |
| 16                              | 823     | 113     | .5209   | 399     | 44 |
| 17                              | 852     | 143     | .5118   | 394     | 43 |
| 18                              | 880     | 173     | .5026   | 389     | 42 |
| 19                              | 909     | 203     | .4936   | 383     | 41 |
| 20                              | .17937  | .18233  | 5.4845  | .98378  | 40 |
| 21                              | 966     | 263     | .4755   | 373     | 39 |
| 22                              | .17995  | 293     | .4665   | 368     | 38 |
| 23                              | .18023  | 323     | .4575   | 362     | 37 |
| 24                              | 052     | 353     | .4486   | 357     | 36 |
| 25                              | .18051  | .18384  | 5.4397  | .98352  | 35 |
| 26                              | 109     | 414     | .4308   | 347     | 34 |
| 27                              | 138     | 444     | .4219   | 341     | 33 |
| 28                              | 166     | 474     | .4131   | 336     | 32 |
| 29                              | 195     | 504     | .4043   | 331     | 31 |
| 30                              | .18224  | .18534  | 5.3955  | .98325  | 30 |
| 31                              | 252     | 564     | .3868   | 320     | 29 |
| 32                              | 281     | 594     | .3781   | 315     | 28 |
| 33                              | 309     | 624     | .3694   | 310     | 27 |
| 34                              | 338     | 654     | .3607   | 304     | 26 |
| 35                              | .18367  | .18684  | 5.3521  | .98299  | 25 |
| 36                              | 395     | 714     | .3435   | 294     | 24 |
| 37                              | 424     | 745     | .3349   | 288     | 23 |
| 38                              | 452     | 775     | .3263   | 283     | 22 |
| 39                              | 481     | 805     | .3178   | 277     | 21 |
| 40                              | .18509  | .18835  | 5.3093  | .98272  | 20 |
| 41                              | 538     | 865     | .3008   | 267     | 19 |
| 42                              | 567     | 895     | .2924   | 261     | 18 |
| 43                              | 595     | 925     | .2839   | 256     | 17 |
| 44                              | 624     | 955     | .2755   | 250     | 16 |
| 45                              | .18652  | .18986  | 5.2672  | .98245  | 15 |
| 46                              | 681     | .19016  | .2588   | 240     | 14 |
| 47                              | 710     | 046     | .2503   | 234     | 13 |
| 48                              | 738     | 076     | .2422   | 229     | 12 |
| 49                              | 767     | 106     | .2339   | 223     | 11 |
| 50                              | .18795  | .19136  | 5.2257  | .98218  | 10 |
| 51                              | 824     | 166     | .2174   | 212     | 9  |
| 52                              | 852     | 197     | .2092   | 207     | 8  |
| 53                              | 881     | 227     | .2011   | 201     | 7  |
| 54                              | 910     | 257     | .1929   | 196     | 6  |
| 55                              | .18938  | .19287  | 5.1848  | .98190  | 5  |
| 56                              | 967     | 317     | .1767   | 185     | 4  |
| 57                              | .18995  | 347     | .1686   | 179     | 3  |
| 58                              | .19024  | 378     | .1606   | 174     | 2  |
| 59                              | 052     | 408     | .1526   | 168     | 1  |
| 60                              | .19081  | .19438  | 5.1446  | .98163  | 0  |
| N. Cos. N. Cot. N. Tan. N. Sin. |         |         |         |         |    |

|                                 | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|---------------------------------|---------|---------|---------|---------|----|
| 0                               | .19081  | .19438  | 5.1446  | .98163  | 60 |
| 1                               | 109     | 468     | .1366   | 157     | 59 |
| 2                               | 138     | 498     | .1286   | 152     | 58 |
| 3                               | 167     | 529     | .1207   | 146     | 57 |
| 4                               | 195     | 559     | .1128   | 140     | 56 |
| 5                               | .19224  | .19589  | 5.1049  | .98135  | 55 |
| 6                               | 252     | 619     | .0970   | 129     | 54 |
| 7                               | 281     | 649     | .0892   | 124     | 53 |
| 8                               | 309     | 680     | .0814   | 118     | 52 |
| 9                               | 338     | 710     | .0736   | 112     | 51 |
| 10                              | .19366  | .19740  | 5.0658  | .98107  | 50 |
| 11                              | 395     | 770     | .0581   | 101     | 49 |
| 12                              | 423     | 801     | .0504   | 96      | 48 |
| 13                              | 452     | 831     | .0427   | 90      | 47 |
| 14                              | 481     | 861     | .0350   | 84      | 46 |
| 15                              | .19509  | .19891  | 5.0273  | .98079  | 45 |
| 16                              | 538     | 921     | .0197   | 73      | 44 |
| 17                              | 566     | 952     | .0121   | 67      | 43 |
| 18                              | 595     | .19982  | 5.0045  | 61      | 42 |
| 19                              | 623     | .20012  | 4.9969  | 56      | 41 |
| 20                              | .19652  | .20042  | 4.9894  | .98050  | 40 |
| 21                              | 680     | 073     | .9819   | 044     | 39 |
| 22                              | 709     | 103     | .9744   | 039     | 38 |
| 23                              | 737     | 133     | .9669   | 033     | 37 |
| 24                              | 766     | 164     | .9594   | 027     | 36 |
| 25                              | .19794  | .20194  | 4.9520  | .98021  | 35 |
| 26                              | 823     | 224     | .9446   | 016     | 34 |
| 27                              | 851     | 254     | .9372   | 010     | 33 |
| 28                              | 880     | 285     | .9298   | .98004  | 32 |
| 29                              | 908     | 315     | .9225   | .97998  | 31 |
| 30                              | .19937  | .20345  | 4.9152  | .97992  | 30 |
| 31                              | 965     | 376     | .9078   | 987     | 29 |
| 32                              | .19994  | 406     | .9006   | 981     | 28 |
| 33                              | .20022  | 436     | .8933   | 975     | 27 |
| 34                              | 051     | 466     | .8860   | 969     | 26 |
| 35                              | .20079  | .20497  | 4.8788  | .97963  | 25 |
| 36                              | 108     | 527     | .8716   | 958     | 24 |
| 37                              | 136     | 557     | .8644   | 952     | 23 |
| 38                              | 165     | 588     | .8573   | 946     | 22 |
| 39                              | 193     | 618     | .8501   | 940     | 21 |
| 40                              | .20222  | .20648  | 4.8430  | .97934  | 20 |
| 41                              | 250     | 679     | .8359   | 928     | 19 |
| 42                              | 279     | 709     | .8288   | 922     | 18 |
| 43                              | 307     | 739     | .8218   | 916     | 17 |
| 44                              | 336     | 770     | .8147   | 910     | 16 |
| 45                              | .20364  | .20800  | 4.8077  | .97905  | 15 |
| 46                              | 393     | 830     | .8007   | 899     | 14 |
| 47                              | 421     | 861     | .7937   | 893     | 13 |
| 48                              | 450     | 891     | .7867   | 887     | 12 |
| 49                              | 478     | 921     | .7798   | 881     | 11 |
| 50                              | .20507  | .20952  | 4.7729  | .97875  | 10 |
| 51                              | 535     | .20982  | .7659   | 869     | 9  |
| 52                              | 563     | .21013  | .7591   | 863     | 8  |
| 53                              | 592     | 043     | .7522   | 857     | 7  |
| 54                              | 620     | 073     | .7453   | 851     | 6  |
| 55                              | .20649  | .21104  | 4.7385  | .97845  | 5  |
| 56                              | 677     | 134     | .7317   | 839     | 4  |
| 57                              | 706     | 164     | .7249   | 833     | 3  |
| 58                              | 734     | 195     | .7181   | 827     | 2  |
| 59                              | 763     | 225     | .7114   | 821     | 1  |
| 60                              | .20791  | .21256  | 4.7046  | .97815  | 0  |
| N. Cos. N. Cot. N. Tan. N. Sin. |         |         |         |         |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .20791  | .21256  | 4.7046  | .97815  | 60 |
| 1  | 820     | 286     | .6979   | 809     | 59 |
| 2  | 848     | 316     | .6912   | 803     | 58 |
| 3  | 877     | 347     | .6845   | 797     | 57 |
| 4  | 905     | 377     | .6779   | 791     | 56 |
| 5  | .20933  | .21408  | 4.6712  | .97784  | 55 |
| 6  | 962     | 438     | .6646   | 778     | 54 |
| 7  | .20990  | 469     | .6580   | 772     | 53 |
| 8  | .21019  | 499     | .6514   | 766     | 52 |
| 9  | 047     | 529     | .6448   | 760     | 51 |
| 10 | .21076  | .21560  | 4.6382  | .97754  | 50 |
| 11 | 104     | 590     | .6317   | 748     | 49 |
| 12 | 132     | 621     | .6252   | 742     | 48 |
| 13 | 161     | 651     | .6187   | 735     | 47 |
| 14 | 189     | 682     | .6122   | 729     | 46 |
| 15 | .21218  | .21712  | 4.6057  | .97723  | 45 |
| 16 | 246     | 743     | .5993   | 717     | 44 |
| 17 | 275     | 773     | .5928   | 711     | 43 |
| 18 | 303     | 804     | .5864   | 705     | 42 |
| 19 | 331     | 834     | .5800   | 698     | 41 |
| 20 | .21360  | .21864  | 4.5736  | .97692  | 40 |
| 21 | 388     | 895     | .5673   | 686     | 39 |
| 22 | 417     | 925     | .5609   | 680     | 38 |
| 23 | 445     | 956     | .5546   | 673     | 37 |
| 24 | 474     | .21986  | .5483   | 667     | 36 |
| 25 | .21502  | .22017  | 4.5420  | .97661  | 35 |
| 26 | 530     | 047     | .5357   | 655     | 34 |
| 27 | 559     | 078     | .5294   | 648     | 33 |
| 28 | 587     | 108     | .5232   | 642     | 32 |
| 29 | 616     | 139     | .5169   | 636     | 31 |
| 30 | .21644  | .22169  | 4.5107  | .97630  | 30 |
| 31 | 672     | 200     | .5045   | 623     | 29 |
| 32 | 701     | 231     | .4983   | 617     | 28 |
| 33 | 729     | 261     | .4922   | 611     | 27 |
| 34 | 758     | 292     | .4860   | 604     | 26 |
| 35 | .21786  | .22322  | 4.4799  | .97598  | 25 |
| 36 | 814     | 353     | .4737   | 592     | 24 |
| 37 | 843     | 383     | .4676   | 585     | 23 |
| 38 | 871     | 414     | .4615   | 579     | 22 |
| 39 | 899     | 444     | .4555   | 573     | 21 |
| 40 | .21928  | .22475  | 4.4494  | .97566  | 20 |
| 41 | 956     | 505     | .4434   | 560     | 19 |
| 42 | .21985  | 536     | .4373   | 553     | 18 |
| 43 | .22013  | 567     | .4313   | 547     | 17 |
| 44 | 041     | 597     | .4253   | 541     | 16 |
| 45 | .22070  | .22628  | 4.4194  | .97534  | 15 |
| 46 | 098     | 658     | .4134   | 528     | 14 |
| 47 | 126     | 689     | .4073   | 521     | 13 |
| 48 | 155     | 719     | .4015   | 515     | 12 |
| 49 | 183     | 750     | .3956   | 508     | 11 |
| 50 | .22212  | .22781  | 4.3897  | .97502  | 10 |
| 51 | 240     | 811     | .3838   | 496     | 9  |
| 52 | 268     | 842     | .3779   | 489     | 8  |
| 53 | 297     | 872     | .3721   | 483     | 7  |
| 54 | 325     | 903     | .3662   | 476     | 6  |
| 55 | .22353  | .22934  | 4.3604  | .97470  | 5  |
| 56 | 382     | 964     | .3546   | 463     | 4  |
| 57 | 410     | .22995  | .3488   | 457     | 3  |
| 58 | 438     | .23026  | .3430   | 450     | 2  |
| 59 | 467     | 056     | .3372   | 444     | 1  |
| 60 | .22495  | .23087  | 4.3315  | .97437  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .22495  | .23087  | 4.3315  | .97437  | 60 |
| 1  | 523     | 117     | .3257   | 430     | 59 |
| 2  | 552     | 148     | .3200   | 424     | 58 |
| 3  | 580     | 179     | .3143   | 417     | 57 |
| 4  | 608     | 209     | .3086   | 411     | 56 |
| 5  | .22637  | .23240  | 4.3029  | .97404  | 55 |
| 6  | 665     | 271     | .2972   | 398     | 54 |
| 7  | 693     | 301     | .2916   | 391     | 53 |
| 8  | 722     | 332     | .2859   | 384     | 52 |
| 9  | 750     | 363     | .2803   | 378     | 51 |
| 10 | .22778  | .23393  | 4.2747  | .97371  | 50 |
| 11 | 807     | 424     | .2691   | 365     | 49 |
| 12 | 835     | 455     | .2635   | 358     | 48 |
| 13 | 863     | 485     | .2580   | 351     | 47 |
| 14 | 892     | 516     | .2524   | 345     | 46 |
| 15 | .22920  | .23547  | 4.2468  | .97338  | 45 |
| 16 | 948     | 578     | .2413   | 331     | 44 |
| 17 | .22977  | 608     | .2358   | 325     | 43 |
| 18 | .23005  | 639     | .2303   | 318     | 42 |
| 19 | 033     | 670     | .2248   | 311     | 41 |
| 20 | .23062  | .23700  | 4.2193  | .97304  | 40 |
| 21 | 090     | 731     | .2139   | 298     | 39 |
| 22 | 118     | 762     | .2084   | 291     | 38 |
| 23 | 146     | 793     | .2030   | 284     | 37 |
| 24 | 175     | 823     | .1976   | 278     | 36 |
| 25 | .23203  | .23854  | 4.1922  | .97271  | 35 |
| 26 | 231     | 885     | .1868   | 264     | 34 |
| 27 | 260     | 916     | .1814   | 257     | 33 |
| 28 | 288     | 946     | .1760   | 251     | 32 |
| 29 | 316     | .23977  | .1706   | 244     | 31 |
| 30 | .23345  | .24008  | 4.1653  | .97237  | 30 |
| 31 | 373     | 039     | .1600   | 230     | 29 |
| 32 | 401     | 069     | .1547   | 223     | 28 |
| 33 | 429     | 100     | .1493   | 217     | 27 |
| 34 | 458     | 131     | .1441   | 210     | 26 |
| 35 | .23486  | .24162  | 4.1388  | .97203  | 25 |
| 36 | 514     | 193     | .1335   | 196     | 24 |
| 37 | 542     | 223     | .1282   | 189     | 23 |
| 38 | 571     | 254     | .1230   | 182     | 22 |
| 39 | 599     | 285     | .1178   | 176     | 21 |
| 40 | .23627  | .24316  | 4.1126  | .97169  | 20 |
| 41 | 656     | 347     | .1074   | 162     | 19 |
| 42 | 684     | 377     | .1022   | 155     | 18 |
| 43 | 712     | 408     | .0970   | 148     | 17 |
| 44 | 740     | 439     | .0918   | 141     | 16 |
| 45 | .23769  | .24470  | 4.0867  | .97134  | 15 |
| 46 | 797     | 501     | .0815   | 127     | 14 |
| 47 | 825     | 532     | .0764   | 120     | 13 |
| 48 | 853     | 562     | .0713   | 113     | 12 |
| 49 | 882     | 593     | .0662   | 106     | 11 |
| 50 | .23910  | .24624  | 4.0611  | .97100  | 10 |
| 51 | 938     | 655     | .0560   | 093     | 9  |
| 52 | 966     | 686     | .0509   | 086     | 8  |
| 53 | .23995  | 717     | .0459   | 079     | 7  |
| 54 | .24023  | 747     | .0408   | 072     | 6  |
| 55 | .24051  | .24778  | 4.0358  | .97065  | 5  |
| 56 | 079     | 809     | .0308   | 058     | 4  |
| 57 | 108     | 840     | .0257   | 051     | 3  |
| 58 | 136     | 871     | .0207   | 044     | 2  |
| 59 | 164     | 902     | .0158   | 037     | 1  |
| 60 | .24192  | .24933  | 4.0108  | .97030  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .24192  | .24933  | 4.0108  | .97030  | 60 |
| 1  | 220     | 964     | .0058   | .023    | 59 |
| 2  | 249     | .24995  | 4.0009  | .015    | 58 |
| 3  | 277     | .25026  | 3.9959  | .008    | 57 |
| 4  | 305     | .056    | .9910   | .97001  | 56 |
| 5  | .24333  | .25087  | 3.9861  | .96994  | 55 |
| 6  | 362     | 118     | .9812   | .987    | 54 |
| 7  | 390     | 149     | .9763   | .980    | 53 |
| 8  | 418     | 180     | .9714   | .973    | 52 |
| 9  | 446     | 211     | .9665   | .966    | 51 |
| 10 | .24474  | .25242  | 3.9617  | .96959  | 50 |
| 11 | 503     | 273     | .9568   | .952    | 49 |
| 12 | 531     | 304     | .9520   | .945    | 48 |
| 13 | 559     | 335     | .9471   | .937    | 47 |
| 14 | 587     | 366     | .9423   | .930    | 46 |
| 15 | .24615  | .25397  | 3.9375  | .96923  | 45 |
| 16 | 644     | 428     | .9327   | .916    | 44 |
| 17 | 672     | 459     | .9279   | .909    | 43 |
| 18 | 700     | 490     | .9232   | .902    | 42 |
| 19 | 728     | 521     | .9184   | .894    | 41 |
| 20 | .24756  | .25552  | 3.9136  | .96887  | 40 |
| 21 | 784     | 583     | .9089   | .880    | 39 |
| 22 | 813     | 614     | .9042   | .873    | 38 |
| 23 | 841     | 645     | .8995   | .866    | 37 |
| 24 | 869     | 676     | .8947   | .858    | 36 |
| 25 | .24897  | .25707  | 3.8900  | .96851  | 35 |
| 26 | 925     | 738     | .8854   | .844    | 34 |
| 27 | 954     | 769     | .8807   | .837    | 33 |
| 28 | .24982  | 800     | .8760   | .829    | 32 |
| 29 | .25010  | 831     | .8714   | .822    | 31 |
| 30 | .25038  | .25862  | 3.8667  | .96815  | 30 |
| 31 | 066     | 893     | .8621   | .807    | 29 |
| 32 | 094     | 924     | .8575   | .800    | 28 |
| 33 | 122     | 955     | .8528   | .793    | 27 |
| 34 | 151     | .25986  | .8482   | .786    | 26 |
| 35 | .25179  | .26017  | 3.8436  | .96778  | 25 |
| 36 | 207     | 048     | .8391   | .771    | 24 |
| 37 | 235     | 079     | .8345   | .764    | 23 |
| 38 | 263     | 110     | .8299   | .756    | 22 |
| 39 | 291     | 141     | .8254   | .749    | 21 |
| 40 | .25320  | .26172  | 3.8208  | .96742  | 20 |
| 41 | 348     | 203     | .8163   | .734    | 19 |
| 42 | 376     | 235     | .8118   | .727    | 18 |
| 43 | 404     | 266     | .8073   | .719    | 17 |
| 44 | 432     | 297     | .8028   | .712    | 16 |
| 45 | .25460  | .26328  | 3.7983  | .96705  | 15 |
| 46 | 488     | 359     | .7938   | .697    | 14 |
| 47 | 516     | 390     | .7893   | .690    | 13 |
| 48 | 545     | 421     | .7848   | .682    | 12 |
| 49 | 573     | 452     | .7804   | .675    | 11 |
| 50 | .25601  | .26483  | 3.7760  | .96667  | 10 |
| 51 | 629     | 515     | .7715   | .660    | 9  |
| 52 | 657     | 546     | .7671   | .653    | 8  |
| 53 | 685     | 577     | .7627   | .645    | 7  |
| 54 | 713     | 608     | .7583   | .638    | 6  |
| 55 | .25741  | .26639  | 3.7539  | .96630  | 5  |
| 56 | 769     | 670     | .7495   | .623    | 4  |
| 57 | 798     | 701     | .7451   | .615    | 3  |
| 58 | 826     | 733     | .7408   | .608    | 2  |
| 59 | 854     | 764     | .7364   | .600    | 1  |
| 60 | .25882  | .26795  | 3.7321  | .96593  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .25882  | .26795  | 3.7321  | .96593  | 60 |
| 1  | 910     | 826     | .7277   | .585    | 59 |
| 2  | 938     | 857     | .7234   | .578    | 58 |
| 3  | 966     | 888     | .7191   | .570    | 57 |
| 4  | .25994  | 920     | .7148   | .562    | 56 |
| 5  | .26022  | .26951  | 3.7105  | .96555  | 55 |
| 6  | 050     | .26982  | .7062   | .547    | 54 |
| 7  | 079     | .27013  | .7019   | .540    | 53 |
| 8  | 107     | 044     | .6976   | .532    | 52 |
| 9  | 135     | 076     | .6933   | .524    | 51 |
| 10 | .26163  | .27107  | 3.6891  | .96517  | 50 |
| 11 | 191     | 138     | .6848   | .509    | 49 |
| 12 | 219     | 169     | .6806   | .502    | 48 |
| 13 | 247     | 201     | .6764   | .494    | 47 |
| 14 | 275     | .2723   | .6722   | .486    | 46 |
| 15 | .26303  | .27263  | 3.6680  | .96479  | 45 |
| 16 | 331     | 294     | .6638   | .471    | 44 |
| 17 | 359     | 326     | .6596   | .463    | 43 |
| 18 | 387     | 357     | .6554   | .456    | 42 |
| 19 | 415     | 388     | .6512   | .448    | 41 |
| 20 | .26443  | .27419  | 3.6470  | .96440  | 40 |
| 21 | 471     | 451     | .6429   | .433    | 39 |
| 22 | 500     | 482     | .6387   | .425    | 38 |
| 23 | 528     | 513     | .6346   | .417    | 37 |
| 24 | 556     | 545     | .6305   | .410    | 36 |
| 25 | .26584  | .27576  | 3.6264  | .96402  | 35 |
| 26 | 612     | 607     | .6222   | .394    | 34 |
| 27 | 640     | 638     | .6181   | .386    | 33 |
| 28 | 668     | 670     | .6140   | .379    | 32 |
| 29 | 696     | 701     | .6100   | .371    | 31 |
| 30 | .26724  | .27732  | 3.6059  | .96363  | 30 |
| 31 | 752     | 764     | .6018   | .355    | 29 |
| 32 | 780     | 795     | .5978   | .347    | 28 |
| 33 | 808     | 826     | .5937   | .340    | 27 |
| 34 | 836     | 858     | .5897   | .332    | 26 |
| 35 | .26864  | .27889  | 3.5856  | .96324  | 25 |
| 36 | 892     | 921     | .5816   | .316    | 24 |
| 37 | 920     | 952     | .5776   | .308    | 23 |
| 38 | 948     | .27983  | .5736   | .301    | 22 |
| 39 | .26976  | .28015  | .5696   | .293    | 21 |
| 40 | .27004  | .28046  | 3.5656  | .96285  | 20 |
| 41 | 032     | 077     | .5616   | .277    | 19 |
| 42 | 060     | 109     | .5576   | .269    | 18 |
| 43 | 088     | 140     | .5536   | .261    | 17 |
| 44 | 116     | 172     | .5497   | .253    | 16 |
| 45 | .27144  | .28203  | 3.5457  | .96246  | 15 |
| 46 | 172     | 234     | .5418   | .238    | 14 |
| 47 | 200     | 266     | .5379   | .230    | 13 |
| 48 | 228     | 297     | .5339   | .222    | 12 |
| 49 | 256     | 329     | .5300   | .214    | 11 |
| 50 | .27284  | .28360  | 3.5261  | .96206  | 10 |
| 51 | 312     | 391     | .5222   | .198    | 9  |
| 52 | 340     | 423     | .5183   | .190    | 8  |
| 53 | 368     | 454     | .5144   | .182    | 7  |
| 54 | 396     | 486     | .5105   | .174    | 6  |
| 55 | .27424  | .28517  | 3.5067  | .96166  | 5  |
| 56 | 452     | 549     | .5028   | .158    | 4  |
| 57 | 480     | 580     | .4989   | .150    | 3  |
| 58 | 508     | 612     | .4951   | .142    | 2  |
| 59 | 536     | 643     | .4912   | .134    | 1  |
| 60 | .27564  | .28675  | 3.4874  | .96126  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .27564  | .28675  | 3.4874  | .96126  | 60 |
| 1  | 592     | 706     | .4836   | 118     | 59 |
| 2  | 620     | 738     | .4798   | 110     | 58 |
| 3  | 648     | 769     | .4760   | 102     | 57 |
| 4  | 676     | 801     | .4722   | 094     | 56 |
| 5  | .27704  | .28832  | 3.4684  | .96086  | 55 |
| 6  | 731     | 864     | .4646   | 078     | 54 |
| 7  | 759     | 895     | .4608   | 070     | 53 |
| 8  | 787     | 927     | .4570   | 062     | 52 |
| 9  | 815     | 958     | .4533   | 054     | 51 |
| 10 | .27843  | .28990  | 3.4495  | .96046  | 50 |
| 11 | 871     | .29021  | .4458   | 037     | 49 |
| 12 | 899     | 033     | .4420   | 029     | 48 |
| 13 | 927     | 084     | .4383   | 021     | 47 |
| 14 | 955     | 116     | .4346   | 013     | 46 |
| 15 | .27983  | .29147  | 3.4308  | .96005  | 45 |
| 16 | .28011  | 179     | .4271   | .95997  | 44 |
| 17 | 039     | 210     | .4234   | 989     | 43 |
| 18 | 067     | 242     | .4197   | 981     | 42 |
| 19 | 095     | 274     | .4160   | 972     | 41 |
| 20 | .28123  | .29305  | 3.4124  | .95994  | 40 |
| 21 | 150     | 337     | .4087   | 956     | 39 |
| 22 | 178     | 368     | .4050   | 948     | 38 |
| 23 | 206     | 400     | .4014   | 940     | 37 |
| 24 | 234     | 432     | .3977   | 931     | 36 |
| 25 | .28262  | .29463  | 3.3941  | .95923  | 35 |
| 26 | 290     | 495     | .3904   | 915     | 34 |
| 27 | 318     | 526     | .3868   | 907     | 33 |
| 28 | 346     | 558     | .3832   | 898     | 32 |
| 29 | 374     | 590     | .3796   | 890     | 31 |
| 30 | .28402  | .29621  | 3.3759  | .95882  | 30 |
| 31 | 429     | 653     | .3723   | 874     | 29 |
| 32 | 457     | 685     | .3687   | 865     | 28 |
| 33 | 485     | 716     | .3652   | 857     | 27 |
| 34 | 513     | 748     | .3616   | 849     | 26 |
| 35 | .28541  | .29780  | 3.3580  | .95841  | 25 |
| 36 | 569     | 811     | .3544   | 832     | 24 |
| 37 | 597     | 843     | .3509   | 824     | 23 |
| 38 | 625     | 875     | .3473   | 816     | 22 |
| 39 | 652     | 906     | .3438   | 807     | 21 |
| 40 | .28680  | .29938  | 3.3402  | .95799  | 20 |
| 41 | 708     | .29970  | .3367   | 791     | 19 |
| 42 | 736     | .30001  | .3332   | 782     | 18 |
| 43 | 764     | 033     | .3297   | 774     | 17 |
| 44 | 792     | 065     | .3261   | 766     | 16 |
| 45 | .28820  | .30097  | 3.3226  | .95757  | 15 |
| 46 | 847     | 128     | .3191   | 749     | 14 |
| 47 | 875     | 160     | .3156   | 740     | 13 |
| 48 | 903     | 192     | .3122   | 732     | 12 |
| 49 | 931     | 224     | .3087   | 724     | 11 |
| 50 | .28959  | .30255  | 3.3052  | .95715  | 10 |
| 51 | .28987  | 287     | .3017   | 707     | 9  |
| 52 | .29015  | 319     | .2983   | 698     | 8  |
| 53 | 042     | 351     | .2948   | 690     | 7  |
| 54 | 070     | 382     | .2914   | 681     | 6  |
| 55 | .29098  | .30414  | 3.2879  | .95673  | 5  |
| 56 | 126     | 446     | .2845   | 664     | 4  |
| 57 | 154     | 478     | .2811   | 656     | 3  |
| 58 | 182     | 509     | .2777   | 647     | 2  |
| 59 | 209     | 541     | .2743   | 639     | 1  |
| 60 | .29237  | .30573  | 3.2709  | .95630  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .29237  | .30573  | 3.2709  | .95630  | 60 |
| 1  | 265     | 605     | .2675   | 622     | 59 |
| 2  | 293     | 637     | .2641   | 613     | 58 |
| 3  | 321     | 669     | .2607   | 605     | 57 |
| 4  | 348     | 700     | .2573   | 596     | 56 |
| 5  | .29376  | .30732  | 3.2539  | .95588  | 55 |
| 6  | 404     | 764     | .2506   | 579     | 54 |
| 7  | 432     | 796     | .2472   | 571     | 53 |
| 8  | 460     | 828     | .2438   | 562     | 52 |
| 9  | 487     | 860     | .2405   | 554     | 51 |
| 10 | .29515  | .30891  | 3.2371  | .95545  | 50 |
| 11 | 543     | 923     | .2338   | 536     | 49 |
| 12 | 571     | 955     | .2305   | 528     | 48 |
| 13 | 599     | .30987  | .2272   | 519     | 47 |
| 14 | 626     | .31019  | .2238   | 511     | 46 |
| 15 | .29654  | .31051  | 3.2205  | .95502  | 45 |
| 16 | 682     | 083     | .2172   | 493     | 44 |
| 17 | 710     | 115     | .2139   | 485     | 43 |
| 18 | 737     | 147     | .2106   | 476     | 42 |
| 19 | 765     | 178     | .2073   | 467     | 41 |
| 20 | .29793  | .31210  | 3.2041  | .95459  | 40 |
| 21 | 821     | 242     | .2008   | 450     | 39 |
| 22 | 849     | 274     | .1975   | 441     | 38 |
| 23 | 876     | 306     | .1943   | 433     | 37 |
| 24 | 904     | 338     | .1910   | 424     | 36 |
| 25 | .29932  | .31370  | 3.1878  | .95415  | 35 |
| 26 | 960     | 402     | .1845   | 407     | 34 |
| 27 | .29987  | 434     | .1813   | 398     | 33 |
| 28 | .30015  | 466     | .1780   | 389     | 32 |
| 29 | 043     | 498     | .1748   | 380     | 31 |
| 30 | .30071  | .31530  | 3.1716  | .95372  | 30 |
| 31 | 098     | 562     | .1684   | 363     | 29 |
| 32 | 126     | 594     | .1652   | 354     | 28 |
| 33 | 154     | 626     | .1620   | 345     | 27 |
| 34 | 182     | 658     | .1588   | 337     | 26 |
| 35 | .30209  | .31690  | 3.1556  | .95328  | 25 |
| 36 | 237     | 722     | .1524   | 319     | 24 |
| 37 | 265     | 754     | .1492   | 310     | 23 |
| 38 | 292     | 786     | .1460   | 301     | 22 |
| 39 | 320     | 818     | .1429   | 293     | 21 |
| 40 | .30348  | .31850  | 3.1397  | .95284  | 20 |
| 41 | 376     | 882     | .1366   | 275     | 19 |
| 42 | 403     | 914     | .1334   | 266     | 18 |
| 43 | 431     | 946     | .1303   | 257     | 17 |
| 44 | 459     | .31978  | .1271   | 248     | 16 |
| 45 | .30486  | .32010  | 3.1240  | .95240  | 15 |
| 46 | 514     | 042     | .1209   | 231     | 14 |
| 47 | 542     | 074     | .1178   | 222     | 13 |
| 48 | 570     | 106     | .1146   | 213     | 12 |
| 49 | 597     | 139     | .1115   | 204     | 11 |
| 50 | .30625  | .32171  | 3.1084  | .95195  | 10 |
| 51 | 653     | 203     | .1053   | 186     | 9  |
| 52 | 680     | 235     | .1022   | 177     | 8  |
| 53 | 708     | 267     | .0991   | 168     | 7  |
| 54 | 736     | 299     | .0961   | 159     | 6  |
| 55 | .30763  | .32331  | 3.0930  | .95150  | 5  |
| 56 | 791     | 363     | .0899   | 142     | 4  |
| 57 | 819     | 396     | .0868   | 133     | 3  |
| 58 | 846     | 428     | .0838   | 124     | 2  |
| 59 | 874     | 460     | .0807   | 115     | 1  |
| 60 | .30902  | .32492  | 3.0777  | .95106  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .30902  | .32492  | 3.0777  | .95106  | 60 |
| 1  | 929     | 524     | .0746   | 097     | 59 |
| 2  | 957     | 556     | .0716   | 088     | 58 |
| 3  | .30985  | 588     | .0686   | 079     | 57 |
| 4  | .31012  | 621     | .0655   | 070     | 56 |
| 5  | .31040  | .32653  | 3.0625  | .95061  | 55 |
| 6  | 068     | 685     | .0595   | 052     | 54 |
| 7  | 095     | 717     | .0565   | 043     | 53 |
| 8  | 123     | 749     | .0535   | 033     | 52 |
| 9  | 151     | 782     | .0505   | 024     | 51 |
| 10 | .31178  | .32814  | 3.0475  | .95015  | 50 |
| 11 | 206     | 846     | .0445   | .95006  | 49 |
| 12 | 233     | 878     | .0415   | .94997  | 48 |
| 13 | 261     | 911     | .0385   | 988     | 47 |
| 14 | 289     | 943     | .0356   | 979     | 46 |
| 15 | .31316  | .32975  | 3.0326  | .94970  | 45 |
| 16 | 344     | .33007  | .0296   | 961     | 44 |
| 17 | 372     | 040     | .0267   | 952     | 43 |
| 18 | 399     | 072     | .0237   | 943     | 42 |
| 19 | 427     | 104     | .0208   | 933     | 41 |
| 20 | .31454  | .33136  | 3.0178  | .94924  | 40 |
| 21 | 482     | 169     | .0149   | 915     | 39 |
| 22 | 510     | 201     | .0120   | 906     | 38 |
| 23 | 537     | 233     | .0090   | 897     | 37 |
| 24 | 565     | 266     | .0061   | 888     | 36 |
| 25 | .31593  | .33298  | 3.0032  | .94878  | 35 |
| 26 | 620     | 330     | 3.0003  | 869     | 34 |
| 27 | 648     | 363     | 2.9974  | 860     | 33 |
| 28 | 675     | 395     | .9945   | 851     | 32 |
| 29 | 703     | 427     | .9916   | 842     | 31 |
| 30 | .31730  | .33460  | 2.9887  | .94832  | 30 |
| 31 | 758     | 492     | .9858   | 823     | 29 |
| 32 | 786     | 524     | .9829   | 814     | 28 |
| 33 | 813     | 557     | .9800   | 805     | 27 |
| 34 | 841     | 589     | .9772   | 795     | 26 |
| 35 | .31868  | .33621  | 2.9743  | .94786  | 25 |
| 36 | 896     | 654     | .9714   | 777     | 24 |
| 37 | 923     | 686     | .9686   | 768     | 23 |
| 38 | 951     | 718     | .9657   | 758     | 22 |
| 39 | .31979  | 751     | .9629   | 749     | 21 |
| 40 | .32006  | .33783  | 2.9600  | .94740  | 20 |
| 41 | 034     | 816     | .9572   | 730     | 19 |
| 42 | 061     | 848     | .9544   | 721     | 18 |
| 43 | 089     | 881     | .9515   | 712     | 17 |
| 44 | 116     | 913     | .9487   | 702     | 16 |
| 45 | .32144  | .33945  | 2.9459  | .94693  | 15 |
| 46 | 171     | .33978  | .9431   | 684     | 14 |
| 47 | 199     | .34010  | .9403   | 674     | 13 |
| 48 | 227     | 043     | .9375   | 665     | 12 |
| 49 | 254     | 075     | .9347   | 656     | 11 |
| 50 | .32282  | .34108  | 2.9319  | .94646  | 10 |
| 51 | 309     | 140     | .9291   | 637     | 9  |
| 52 | 337     | 173     | .9263   | 627     | 8  |
| 53 | 364     | 205     | .9235   | 618     | 7  |
| 54 | 392     | 238     | .9208   | 609     | 6  |
| 55 | .32419  | .34270  | 2.9180  | .94599  | 5  |
| 56 | 447     | 303     | .9152   | 590     | 4  |
| 57 | 474     | 335     | .9125   | 580     | 3  |
| 58 | 502     | 368     | .9097   | 571     | 2  |
| 59 | 529     | 400     | .9070   | 561     | 1  |
| 60 | .32557  | .34433  | 2.9042  | .94552  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
|    | .32557  | .34433  | 2.9042  | .94552  | 60 |
|    | 584     | 46      | .901    | 542     | 59 |
|    | 612     | 49      | .898    | 533     | 58 |
|    | 639     | 53      | .896    | 523     | 57 |
|    | 667     | 563     | .893    | 514     | 56 |
|    | .32694  | .34591  | 2.890   | .94504  | 55 |
|    | 722     | 628     | .887    | 495     | 54 |
|    | 749     | 661     | .885    | 485     | 53 |
|    | 777     | 693     | .882    | 476     | 52 |
|    | 804     | 726     | .879    | 466     | 51 |
| 10 | .32832  | .34758  | 2.877   | .94457  | 50 |
| 11 | 859     |         | .874    | 447     | 49 |
| 12 | 887     | 824     | .871    | 438     | 48 |
| 13 | 914     | 856     | .868    | 428     | 47 |
| 14 | 942     | 889     | .866    | 418     | 46 |
| 15 | .32969  | .34922  | 2.863   | .94409  | 45 |
| 16 | .32997  | 95      | .8609   | 399     | 44 |
| 17 | .33024  | .34987  | .8582   | 390     | 43 |
| 18 | 051     | .35020  | .8556   | 380     | 42 |
| 19 | 079     | 05      | .8529   | 370     | 41 |
| 20 | .33106  | .35085  | 2.8502  | .94361  | 40 |
| 21 | 134     | 118     | .8476   | 351     | 39 |
| 22 | 161     | 150     | .8449   | 342     | 38 |
| 23 | 189     | 1       | .8423   | 332     | 37 |
| 24 | 216     | 216     | .8397   | 322     | 36 |
| 25 | .33244  | .35248  | 2.8370  | .94313  | 35 |
| 26 | 281     | 281     | .8344   | 303     | 34 |
| 27 | 298     | 314     | .8318   | 293     | 33 |
| 28 | 326     | 346     | .8291   | 284     | 32 |
| 29 | .333    | .379    | .8265   | 274     | 31 |
| 30 | .33381  | .35412  | 2.8239  | .94264  | 30 |
| 31 | 408     | 445     | .8213   | 254     | 29 |
| 32 | 436     | 477     | .8187   | 245     | 28 |
| 33 | 463     | 510     | .8161   | 235     | 27 |
| 34 | 490     | 543     | .8135   | 225     | 26 |
| 35 | .33518  | .35576  | 2.8109  | .94215  | 25 |
| 36 | 545     | 608     | .8083   | 206     | 24 |
| 37 | 573     | 641     | .8057   | 196     | 23 |
| 38 | 600     | 674     | .8032   | 186     |    |
| 39 | 627     | 707     | .8006   | 176     |    |
| 40 | .33655  | .35740  | 2.7980  | .94167  | 20 |
| 41 | 682     | 772     | .7955   | 157     | 19 |
| 42 | 710     | 805     | .7929   | 147     | 18 |
| 43 | 737     | 838     | .7903   | 137     | 17 |
| 44 | 764     | 871     | .7878   | 127     | 16 |
| 45 | .33792  | .35904  | 2.7852  | .94118  | 15 |
| 46 | 819     | 937     | .7827   | 108     | 14 |
| 47 | 846     | .35969  | .7801   |         | 13 |
| 48 | 874     | .36002  | .7776   |         | 12 |
| 49 | 901     | 035     | .7751   | 078     |    |
| 50 | .33929  | .36068  | 2.7725  | .94068  |    |
| 51 | 956     | 101     | .7700   | 058     |    |
| 52 | .33983  | 134     | .7675   | 049     |    |
| 53 | .34011  | 167     | .7650   | 039     |    |
| 54 | 038     | 199     | .7625   | 029     |    |
| 55 | .34065  | .36232  | .7600   | .94019  |    |
| 56 | 093     | 265     | .7575   | .94009  |    |
| 57 | 120     | 298     | .7550   |         |    |
| 58 | 147     | 331     | .7525   |         |    |
| 59 | .34173  | .364    | .7500   | .979    |    |
| 60 | .34202  | .36397  | 2.7475  | .93969  |    |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |



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|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .34202  | .36397  | 2.7473  | .93969  | 60 |
| 1  | 229     | 430     | .7450   | 959     | 59 |
| 2  | 257     | 463     | .7425   | 949     | 58 |
| 3  | 284     | 496     | .7400   | 939     | 57 |
| 4  | 311     | 529     | .7376   | 929     | 56 |
| 5  | .34339  | .36502  | 2.7351  | .93919  | 55 |
| 6  | 366     | 595     | .7326   | 909     | 54 |
| 7  | 393     | 628     | .7302   | 899     | 53 |
| 8  | 421     | 661     | .7277   | 889     | 52 |
| 9  | 448     | 694     | .7253   | 879     | 51 |
| 10 | .34475  | .36727  | 2.7228  | .93869  | 50 |
| 11 | 503     | 760     | .7204   | 859     | 49 |
| 12 | 530     | 793     | .7179   | 849     | 48 |
| 13 | 557     | 826     | .7155   | 839     | 47 |
| 14 | 584     | 859     | .7130   | 829     | 46 |
| 15 | .34612  | .36892  | 2.7106  | .93819  | 45 |
| 16 | 639     | 925     | .7082   | 809     | 44 |
| 17 | 666     | 958     | .7058   | 799     | 43 |
| 18 | 694     | .36991  | .7034   | 789     | 42 |
| 19 | 721     | .37024  | .7009   | 779     | 41 |
| 20 | .34748  | .37057  | 2.6985  | .93769  | 40 |
| 21 | 775     | 090     | .6961   | 759     | 39 |
| 22 | 803     | 123     | .6937   | 748     | 38 |
| 23 | 830     | 157     | .6913   | 738     | 37 |
| 24 | 857     | 190     | .6889   | 728     | 36 |
| 25 | .34884  | .37223  | 2.6865  | .93718  | 35 |
| 26 | 912     | 256     | .6841   | 708     | 34 |
| 27 | 939     | 289     | .6818   | 698     | 33 |
| 28 | 966     | 322     | .6794   | 688     | 32 |
| 29 | .34993  | 355     | .6770   | 677     | 31 |
| 30 | .35021  | .37388  | 2.6746  | .93667  | 30 |
| 31 | 048     | 422     | .6723   | 657     | 29 |
| 32 | 075     | 455     | .6699   | 647     | 28 |
| 33 | 102     | 488     | .6675   | 637     | 27 |
| 34 | 130     | 521     | .6652   | 626     | 26 |
| 35 | .35157  | .37554  | 2.6628  | .93616  | 25 |
| 36 | 184     | 588     | .6605   | 606     | 24 |
| 37 | 211     | 621     | .6581   | 596     | 23 |
| 38 | 239     | 654     | .6558   | 585     | 22 |
| 39 | 266     | 687     | .6534   | 575     | 21 |
| 40 | .35293  | .37720  | 2.6511  | .93565  | 20 |
| 41 | 320     | 754     | .6488   | 555     | 19 |
| 42 | 347     | 787     | .6464   | 544     | 18 |
| 43 | 375     | 820     | .6441   | 534     | 17 |
| 44 | 402     | 853     | .6418   | 524     | 16 |
| 45 | .35429  | .37887  | 2.6395  | .93514  | 15 |
| 46 | 456     | 920     | .6371   | 503     | 14 |
| 47 | 484     | 953     | .6348   | 493     | 13 |
| 48 | 511     | .37986  | .6325   | 483     | 12 |
| 49 | 538     | .38020  | .6302   | 472     | 11 |
| 50 | .35565  | .38053  | 2.6279  | .93462  | 10 |
| 51 | 592     | 086     | .6256   | 452     | 9  |
| 52 | 619     | 120     | .6233   | 441     | 8  |
| 53 | 647     | 153     | .6210   | 431     | 7  |
| 54 | 674     | 186     | .6187   | 420     | 6  |
| 55 | .35701  | .38220  | 2.6165  | .93410  | 5  |
| 56 | 728     | 253     | .6142   | 400     | 4  |
| 57 | 755     | 286     | .6119   | 389     | 3  |
| 58 | 782     | 320     | .6096   | 379     | 2  |
| 59 | 810     | 353     | .6074   | 368     | 1  |
| 60 | .35837  | .38386  | 2.6051  | .93358  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

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|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .35837  | .38386  | 2.6051  | .93358  | 60 |
| 1  | 864     | 420     | .6028   | 348     | 59 |
| 2  | 891     | 453     | .6006   | 337     | 58 |
| 3  | 918     | 487     | .5983   | 327     | 57 |
| 4  | 945     | 520     | .5961   | 316     | 56 |
| 5  | .35973  | .38553  | 2.5938  | .93306  | 55 |
| 6  | .36000  | 587     | .5916   | 295     | 54 |
| 7  | 027     | 620     | .5893   | 285     | 53 |
| 8  | 054     | 654     | .5871   | 274     | 52 |
| 9  | 081     | 687     | .5848   | 264     | 51 |
| 10 | .36108  | .38721  | 2.5826  | .93253  | 50 |
| 11 | 135     | 754     | .5804   | 243     | 49 |
| 12 | 162     | 787     | .5782   | 232     | 48 |
| 13 | 190     | 821     | .5759   | 222     | 47 |
| 14 | 217     | 854     | .5737   | 211     | 46 |
| 15 | .36244  | .38888  | 2.5715  | .93201  | 45 |
| 16 | 271     | 921     | .5693   | 190     | 44 |
| 17 | 298     | 955     | .5671   | 180     | 43 |
| 18 | 325     | .38988  | .5649   | 169     | 42 |
| 19 | 352     | .39022  | .5627   | 159     | 41 |
| 20 | .36379  | .39055  | 2.5605  | .93148  | 40 |
| 21 | 406     | 089     | .5583   | 137     | 39 |
| 22 | 434     | 122     | .5561   | 127     | 38 |
| 23 | 461     | 156     | .5539   | 116     | 37 |
| 24 | 488     | 190     | .5517   | 106     | 36 |
| 25 | .36515  | .39223  | 2.5495  | .93095  | 35 |
| 26 | 542     | 257     | .5473   | 084     | 34 |
| 27 | 569     | 290     | .5452   | 074     | 33 |
| 28 | 596     | 324     | .5430   | 063     | 32 |
| 29 | 623     | 357     | .5408   | 052     | 31 |
| 30 | .36650  | .39391  | 2.5386  | .93042  | 30 |
| 31 | 677     | 425     | .5365   | 031     | 29 |
| 32 | 704     | 458     | .5343   | 020     | 28 |
| 33 | 731     | 492     | .5322   | .93010  | 27 |
| 34 | 758     | 526     | .5300   | .92999  | 26 |
| 35 | .36785  | .39559  | 2.5279  | .92988  | 25 |
| 36 | 812     | 593     | .5257   | 978     | 24 |
| 37 | 839     | 626     | .5236   | 967     | 23 |
| 38 | 867     | 660     | .5214   | 956     | 22 |
| 39 | 894     | 694     | .5193   | 945     | 21 |
| 40 | .36921  | .39727  | 2.5172  | .92935  | 20 |
| 41 | 948     | 761     | .5150   | 924     | 19 |
| 42 | .36975  | 795     | .5129   | 913     | 18 |
| 43 | .37002  | 829     | .5108   | 902     | 17 |
| 44 | 029     | 862     | .5086   | 892     | 16 |
| 45 | .37056  | .39896  | 2.5065  | .92881  | 15 |
| 46 | 083     | 930     | .5044   | 870     | 14 |
| 47 | 110     | 963     | .5023   | 859     | 13 |
| 48 | 137     | .39997  | .5002   | 849     | 12 |
| 49 | 164     | .40031  | .4981   | 838     | 11 |
| 50 | .37191  | .40065  | 2.4960  | .92827  | 10 |
| 51 | 218     | 098     | .4939   | 816     | 9  |
| 52 | 245     | 132     | .4918   | 805     | 8  |
| 53 | 272     | 166     | .4897   | 794     | 7  |
| 54 | 299     | 200     | .4876   | 784     | 6  |
| 55 | .37326  | .40234  | 2.4855  | .92773  | 5  |
| 56 | 353     | 267     | .4834   | 762     | 4  |
| 57 | 380     | 301     | .4813   | 751     | 3  |
| 58 | 407     | 335     | .4792   | 740     | 2  |
| 59 | 434     | 369     | .4772   | 729     | 1  |
| 60 | .37461  | .40403  | 2.4751  | .92718  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

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|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .37461  | .40403  | 2.4751  | .92718  | 60 |
| 1  | 488     | 436     | .4730   | 707     | 59 |
| 2  | 515     | 470     | .4709   | 697     | 58 |
| 3  | 542     | 504     | .4689   | 686     | 57 |
| 4  | 569     | 538     | .4668   | 675     | 56 |
| 5  | .37595  | .40572  | 2.4648  | .92664  | 55 |
| 6  | 622     | 606     | .4627   | 653     | 54 |
| 7  | 649     | 640     | .4606   | 642     | 53 |
| 8  | 676     | 674     | .4586   | 631     | 52 |
| 9  | 703     | 707     | .4566   | 620     | 51 |
| 10 | .37730  | .40741  | 2.4545  | .92609  | 50 |
| 11 | 757     | 775     | .4525   | 598     | 49 |
| 12 | 784     | 809     | .4504   | 587     | 48 |
| 13 | 811     | 843     | .4484   | 576     | 47 |
| 14 | 838     | 877     | .4464   | 565     | 46 |
| 15 | .37865  | .40911  | 2.4443  | .92554  | 45 |
| 16 | 892     | 945     | .4423   | 543     | 44 |
| 17 | 919     | .40979  | .4403   | 532     | 43 |
| 18 | 946     | .41013  | .4383   | 521     | 42 |
| 19 | 973     | 047     | .4362   | 510     | 41 |
| 20 | .37999  | .41081  | 2.4342  | .92499  | 40 |
| 21 | .38026  | 115     | .4322   | 488     | 39 |
| 22 | 053     | 149     | .4302   | 477     | 38 |
| 23 | 080     | 183     | .4282   | 466     | 37 |
| 24 | 107     | 217     | .4262   | 455     | 36 |
| 25 | .38134  | .41251  | 2.4242  | .92444  | 35 |
| 26 | 161     | 285     | .4222   | 432     | 34 |
| 27 | 188     | 319     | .4202   | 421     | 33 |
| 28 | 215     | 353     | .4182   | 410     | 32 |
| 29 | 241     | 387     | .4162   | 399     | 31 |
| 30 | .38268  | .41421  | 2.4142  | .92388  | 30 |
| 31 | 295     | 455     | .4122   | 377     | 29 |
| 32 | 322     | 490     | .4102   | 366     | 28 |
| 33 | 349     | 524     | .4083   | 355     | 27 |
| 34 | 376     | 558     | .4063   | 343     | 26 |
| 35 | .38403  | .41592  | 2.4043  | .92332  | 25 |
| 36 | 430     | 626     | .4023   | 321     | 24 |
| 37 | 456     | 660     | .4004   | 310     | 23 |
| 38 | 483     | 694     | .3984   | 299     | 22 |
| 39 | 510     | 728     | .3964   | 287     | 21 |
| 40 | .38537  | .41763  | 2.3945  | .92276  | 20 |
| 41 | 564     | 797     | .3925   | 265     | 19 |
| 42 | 591     | 831     | .3906   | 254     | 18 |
| 43 | 617     | 865     | .3886   | 243     | 17 |
| 44 | 644     | 899     | .3867   | 231     | 16 |
| 45 | .38671  | .41933  | 2.3847  | .92220  | 15 |
| 46 | 698     | .41968  | .3828   | 209     | 14 |
| 47 | 725     | .42002  | .3808   | 198     | 13 |
| 48 | 752     | 036     | .3789   | 186     | 12 |
| 49 | 778     | 070     | .3770   | 175     | 11 |
| 50 | .38805  | .42105  | 2.3750  | .92164  | 10 |
| 51 | 832     | 139     | .3731   | 152     | 9  |
| 52 | 859     | 173     | .3712   | 141     | 8  |
| 53 | 886     | 207     | .3693   | 130     | 7  |
| 54 | 912     | 242     | .3673   | 119     | 6  |
| 55 | .38939  | .42276  | 2.3654  | .92107  | 5  |
| 56 | 966     | 310     | .3635   | 096     | 4  |
| 57 | .38993  | 345     | .3616   | 085     | 3  |
| 58 | .39020  | 379     | .3597   | 073     | 2  |
| 59 | 046     | 413     | .3578   | 062     | 1  |
| 60 | .39073  | .42447  | 2.3559  | .92050  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

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|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .39073  | .42447  | 2.3559  | .92050  | 60 |
| 1  | 100     | 482     | .3539   | 039     | 59 |
| 2  | 127     | 516     | .3520   | 028     | 58 |
| 3  | 153     | 551     | .3501   | 016     | 57 |
| 4  | 180     | 585     | .3483   | .92005  | 56 |
| 5  | .39207  | .42619  | 2.3464  | .91994  | 55 |
| 6  | 234     | 654     | .3445   | 982     | 54 |
| 7  | 260     | 688     | .3426   | 971     | 53 |
| 8  | 287     | 722     | .3407   | 959     | 52 |
| 9  | 314     | 757     | .3388   | 948     | 51 |
| 10 | .39341  | .42791  | 2.3369  | .91936  | 50 |
| 11 | 367     | 826     | .3351   | 925     | 49 |
| 12 | 394     | 860     | .3332   | 914     | 48 |
| 13 | 421     | 894     | .3313   | 902     | 47 |
| 14 | 448     | 929     | .3294   | 891     | 46 |
| 15 | .39474  | .42963  | 2.3276  | .91879  | 45 |
| 16 | 501     | .42998  | .3257   | 868     | 44 |
| 17 | 528     | .43032  | .3238   | 856     | 43 |
| 18 | 555     | 067     | .3220   | 845     | 42 |
| 19 | 581     | 101     | .3201   | 833     | 41 |
| 20 | .39608  | .43136  | 2.3183  | .91822  | 40 |
| 21 | 635     | 170     | .3164   | 810     | 39 |
| 22 | 661     | 205     | .3146   | 799     | 38 |
| 23 | 688     | 239     | .3127   | 787     | 37 |
| 24 | 715     | 274     | .3109   | 775     | 36 |
| 25 | .39741  | .43308  | 2.3090  | .91764  | 35 |
| 26 | 768     | 343     | .3072   | 752     | 34 |
| 27 | 795     | 378     | .3053   | 741     | 33 |
| 28 | 822     | 412     | .3035   | 729     | 32 |
| 29 | 848     | 447     | .3017   | 718     | 31 |
| 30 | .39875  | .43481  | 2.2998  | .91706  | 30 |
| 31 | 902     | 516     | .2980   | 694     | 29 |
| 32 | 928     | 550     | .2962   | 683     | 28 |
| 33 | 955     | 585     | .2944   | 671     | 27 |
| 34 | .39982  | 620     | .2925   | 660     | 26 |
| 35 | .40008  | .43654  | 2.2907  | .91648  | 25 |
| 36 | 035     | 689     | .2889   | 636     | 24 |
| 37 | 062     | 724     | .2871   | 625     | 23 |
| 38 | 088     | 758     | .2853   | 613     | 22 |
| 39 | 115     | 793     | .2835   | 601     | 21 |
| 40 | .40141  | .43828  | 2.2817  | .91590  | 20 |
| 41 | 168     | 862     | .2799   | 578     | 19 |
| 42 | 195     | 897     | .2781   | 566     | 18 |
| 43 | 221     | 932     | .2763   | 555     | 17 |
| 44 | 248     | .43966  | .2745   | 543     | 16 |
| 45 | .40275  | .44001  | 2.2727  | .91531  | 15 |
| 46 | 301     | 036     | .2709   | 519     | 14 |
| 47 | 328     | 071     | .2691   | 508     | 13 |
| 48 | 355     | 105     | .2673   | 496     | 12 |
| 49 | 381     | 140     | .2655   | 484     | 11 |
| 50 | .40408  | .44175  | 2.2637  | .91472  | 10 |
| 51 | 434     | 210     | .2620   | 461     | 9  |
| 52 | 461     | 244     | .2602   | 449     | 8  |
| 53 | 488     | 279     | .2584   | 437     | 7  |
| 54 | 514     | 314     | .2566   | 425     | 6  |
| 55 | .40541  | .44349  | 2.2549  | .91414  | 5  |
| 56 | 567     | 384     | .2531   | 402     | 4  |
| 57 | 594     | 418     | .2513   | 390     | 3  |
| 58 | 621     | 453     | .2496   | 378     | 2  |
| 59 | 647     | 488     | .2478   | 366     | 1  |
| 60 | .40674  | .44523  | 2.2460  | .91355  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

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| '                                 | N. Sin. | N. Tan. | N. Cot. | N. Cos. | '  |
|-----------------------------------|---------|---------|---------|---------|----|
| 0                                 | .40674  | .44523  | 2.2460  | .91353  | 60 |
| 1                                 | 700     | 558     | .2443   | 343     | 59 |
| 2                                 | 727     | 593     | .2425   | 331     | 58 |
| 3                                 | 753     | 627     | .2408   | 319     | 57 |
| 4                                 | 780     | 662     | .2390   | 307     | 56 |
| 5                                 | .40806  | .44697  | 2.2373  | .91295  | 55 |
| 6                                 | 833     | 732     | .2355   | 283     | 54 |
| 7                                 | 860     | 767     | .2338   | 272     | 53 |
| 8                                 | 886     | 802     | .2320   | 260     | 52 |
| 9                                 | 913     | 837     | .2303   | 248     | 51 |
| 10                                | .40939  | .44872  | 2.2286  | .91236  | 50 |
| 11                                | 966     | 907     | .2268   | 224     | 49 |
| 12                                | .40992  | .44921  | .2251   | 212     | 48 |
| 13                                | .41019  | .44977  | .2234   | 200     | 47 |
| 14                                | 045     | .45012  | .2216   | 188     | 46 |
| 15                                | .41072  | .45047  | 2.2199  | .91176  | 45 |
| 16                                | 098     | 082     | .2182   | 164     | 44 |
| 17                                | 123     | 117     | .2165   | 152     | 43 |
| 18                                | 151     | 152     | .2148   | 140     | 42 |
| 19                                | 178     | 187     | .2130   | 128     | 41 |
| 20                                | .41204  | .45222  | 2.2113  | .91116  | 40 |
| 21                                | 231     | 257     | .2096   | 104     | 39 |
| 22                                | 257     | 292     | .2079   | 092     | 38 |
| 23                                | 284     | 327     | .2062   | 080     | 37 |
| 24                                | 310     | 362     | .2045   | 068     | 36 |
| 25                                | .41337  | .45397  | 2.2028  | .91056  | 35 |
| 26                                | 363     | 432     | .2011   | 044     | 34 |
| 27                                | 390     | 467     | .1994   | 032     | 33 |
| 28                                | 416     | 502     | .1977   | 020     | 32 |
| 29                                | 443     | 538     | .1960   | .91008  | 31 |
| 30                                | .41469  | .45573  | 2.1943  | .90996  | 30 |
| 31                                | 496     | 608     | .1926   | 984     | 29 |
| 32                                | 522     | 643     | .1909   | 972     | 28 |
| 33                                | 549     | 678     | .1892   | 960     | 27 |
| 34                                | 575     | 713     | .1876   | 948     | 26 |
| 35                                | .41602  | .45748  | 2.1859  | .90936  | 25 |
| 36                                | 628     | 784     | .1842   | 924     | 24 |
| 37                                | 655     | 819     | .1825   | 911     | 23 |
| 38                                | 681     | 854     | .1808   | 899     | 22 |
| 39                                | 707     | 889     | .1792   | 887     | 21 |
| 40                                | .41733  | .45921  | 2.1775  | .90875  | 20 |
| 41                                | 760     | 960     | .1758   | 863     | 19 |
| 42                                | 787     | .45993  | .1742   | 851     | 18 |
| 43                                | 813     | .46030  | .1725   | 839     | 17 |
| 44                                | 840     | 065     | .1708   | 826     | 16 |
| 45                                | .41866  | .46101  | 2.1692  | .90814  | 15 |
| 46                                | 892     | 136     | .1675   | 802     | 14 |
| 47                                | 919     | 171     | .1659   | 790     | 13 |
| 48                                | 945     | 206     | .1642   | 778     | 12 |
| 49                                | 972     | 242     | .1625   | 766     | 11 |
| 50                                | .41998  | .46277  | 2.1609  | .90753  | 10 |
| 51                                | .42024  | 312     | .1592   | 741     | 9  |
| 52                                | 051     | 348     | .1576   | 729     | 8  |
| 53                                | 077     | 383     | .1560   | 717     | 7  |
| 54                                | 104     | 418     | .1543   | 704     | 6  |
| 55                                | .42130  | .46454  | 2.1527  | .90692  | 5  |
| 56                                | 156     | 489     | .1510   | 680     | 4  |
| 57                                | 183     | 523     | .1494   | 668     | 3  |
| 58                                | 209     | 560     | .1478   | 655     | 2  |
| 59                                | 235     | 595     | .1461   | 643     | 1  |
| 60                                | .42262  | .46631  | 2.1445  | .90631  | 0  |
| N. Cos. N. Cot. N. Tan. N. Sin. ' |         |         |         |         |    |

| '                                 | N. Sin. | N. Tan. | N. Cot. | N. Cos. | '  |
|-----------------------------------|---------|---------|---------|---------|----|
| 0                                 | .42262  | .46631  | 2.1445  | .90631  | 60 |
| 1                                 | 288     | 666     | .1429   | 618     | 59 |
| 2                                 | 313     | 702     | .1413   | 606     | 58 |
| 3                                 | 341     | 737     | .1396   | 594     | 57 |
| 4                                 | 367     | 772     | .1380   | 582     | 56 |
| 5                                 | .42394  | .46808  | 2.1364  | .90569  | 55 |
| 6                                 | 420     | 843     | .1348   | 557     | 54 |
| 7                                 | 446     | 879     | .1332   | 545     | 53 |
| 8                                 | 473     | 914     | .1315   | 532     | 52 |
| 9                                 | 499     | 950     | .1299   | 520     | 51 |
| 10                                | .42525  | .46985  | 2.1283  | .90507  | 50 |
| 11                                | 552     | .47021  | .1267   | 495     | 49 |
| 12                                | 578     | 056     | .1251   | 483     | 48 |
| 13                                | 604     | 092     | .1235   | 470     | 47 |
| 14                                | 631     | 128     | .1219   | 458     | 46 |
| 15                                | .42657  | .47163  | 2.1203  | .90446  | 45 |
| 16                                | 683     | 199     | .1187   | 433     | 44 |
| 17                                | 709     | 234     | .1171   | 421     | 43 |
| 18                                | 736     | 270     | .1155   | 408     | 42 |
| 19                                | 762     | 305     | .1139   | 396     | 41 |
| 20                                | .42788  | .47341  | 2.1123  | .90383  | 40 |
| 21                                | 815     | 377     | .1107   | 371     | 39 |
| 22                                | 841     | 412     | .1092   | 358     | 38 |
| 23                                | 867     | 448     | .1076   | 346     | 37 |
| 24                                | 894     | 483     | .1060   | 334     | 36 |
| 25                                | .42920  | .47519  | 2.1044  | .90321  | 35 |
| 26                                | 946     | 553     | .1028   | 309     | 34 |
| 27                                | 972     | 590     | .1013   | 296     | 33 |
| 28                                | .42999  | 626     | .0997   | 284     | 32 |
| 29                                | .43023  | 662     | .0981   | 271     | 31 |
| 30                                | .43051  | .47698  | 2.0965  | .90259  | 30 |
| 31                                | 077     | 733     | .0950   | 246     | 29 |
| 32                                | 104     | 769     | .0934   | 233     | 28 |
| 33                                | 130     | 805     | .0918   | 221     | 27 |
| 34                                | 156     | 840     | .0903   | 208     | 26 |
| 35                                | .43182  | .47876  | 2.0887  | .90196  | 25 |
| 36                                | 209     | 912     | .0872   | 183     | 24 |
| 37                                | 235     | 948     | .0856   | 171     | 23 |
| 38                                | 261     | .47984  | .0840   | 158     | 22 |
| 39                                | 287     | .48019  | .0823   | 146     | 21 |
| 40                                | .43313  | .48055  | 2.0809  | .90133  | 20 |
| 41                                | 340     | 091     | .0794   | 120     | 19 |
| 42                                | 366     | 127     | .0778   | 108     | 18 |
| 43                                | 392     | 163     | .0763   | 095     | 17 |
| 44                                | 418     | 198     | .0748   | 082     | 16 |
| 45                                | .43443  | .48234  | 2.0732  | .90070  | 15 |
| 46                                | 471     | 270     | .0717   | 057     | 14 |
| 47                                | 497     | 306     | .0701   | 045     | 13 |
| 48                                | 523     | 342     | .0686   | 032     | 12 |
| 49                                | 549     | 378     | .0671   | 019     | 11 |
| 50                                | .43575  | .48414  | 2.0655  | .90007  | 10 |
| 51                                | 602     | 450     | .0640   | .89994  | 9  |
| 52                                | 628     | 486     | .0625   | 981     | 8  |
| 53                                | 654     | 521     | .0609   | 968     | 7  |
| 54                                | 680     | 557     | .0594   | 956     | 6  |
| 55                                | .43706  | .48593  | 2.0579  | .89943  | 5  |
| 56                                | 733     | 629     | .0564   | 930     | 4  |
| 57                                | 759     | 665     | .0549   | 918     | 3  |
| 58                                | 785     | 701     | .0533   | 905     | 2  |
| 59                                | 811     | 737     | .0518   | 892     | 1  |
| 60                                | .43837  | .48773  | 2.0503  | .89879  | 0  |
| N. Cos. N. Cot. N. Tan. N. Sin. ' |         |         |         |         |    |

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|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .43837  | .48773  | 2.0503  | .89879  | 60 |
| 1  | 863     | 809     | .0488   | 867     | 59 |
| 2  | 889     | 845     | .0473   | 854     | 58 |
| 3  | 916     | 881     | .0458   | 841     | 57 |
| 4  | 942     | 917     | .0443   | 828     | 56 |
| 5  | .43968  | .48953  | 2.0428  | .89816  | 55 |
| 6  | .43994  | .48989  | .0413   | 803     | 54 |
| 7  | .44020  | .49026  | .0398   | 790     | 53 |
| 8  | 046     | 062     | .0383   | 777     | 52 |
| 9  | 072     | 098     | .0368   | 764     | 51 |
| 10 | .44098  | .49134  | 2.0353  | .89752  | 50 |
| 11 | 124     | 170     | .0338   | 739     | 49 |
| 12 | 151     | 206     | .0323   | 726     | 48 |
| 13 | 177     | 242     | .0308   | 713     | 47 |
| 14 | 203     | 278     | .0293   | 700     | 46 |
| 15 | .44229  | .49315  | 2.0278  | .89687  | 45 |
| 16 | 255     | 351     | .0263   | 674     | 44 |
| 17 | 281     | 387     | .0248   | 662     | 43 |
| 18 | 307     | 423     | .0233   | 649     | 42 |
| 19 | 333     | 459     | .0219   | 636     | 41 |
| 20 | .44359  | .49495  | 2.0204  | .89623  | 40 |
| 21 | 385     | 532     | .0189   | 610     | 39 |
| 22 | 411     | 568     | .0174   | 597     | 38 |
| 23 | 437     | 604     | .0160   | 584     | 37 |
| 24 | 464     | 640     | .0145   | 571     | 36 |
| 25 | .44490  | .49677  | 2.0130  | .89558  | 35 |
| 26 | 516     | 713     | .0115   | 545     | 34 |
| 27 | 542     | 749     | .0101   | 532     | 33 |
| 28 | 568     | 786     | .0086   | 519     | 32 |
| 29 | 594     | 822     | .0072   | 506     | 31 |
| 30 | .44620  | .49858  | 2.0057  | .89493  | 30 |
| 31 | 646     | 894     | .0042   | 480     | 29 |
| 32 | 672     | 931     | .0028   | 467     | 28 |
| 33 | 698     | .49967  | 2.0013  | 454     | 27 |
| 34 | 724     | .50004  | 1.9999  | 441     | 26 |
| 35 | .44750  | .50040  | 1.9984  | .89428  | 25 |
| 36 | 776     | 076     | .9970   | 415     | 24 |
| 37 | 802     | 113     | .9955   | 402     | 23 |
| 38 | 828     | 149     | .9941   | 389     | 22 |
| 39 | 854     | 185     | .9926   | 376     | 21 |
| 40 | .44880  | .50222  | 1.9912  | .89363  | 20 |
| 41 | 906     | 258     | .9897   | 350     | 19 |
| 42 | 932     | 295     | .9883   | 337     | 18 |
| 43 | 958     | 331     | .9868   | 324     | 17 |
| 44 | .44984  | 368     | .9854   | 311     | 16 |
| 45 | .45010  | .50404  | 1.9840  | .89298  | 15 |
| 46 | 036     | 441     | .9825   | 285     | 14 |
| 47 | 062     | 477     | .9811   | 272     | 13 |
| 48 | 088     | 514     | .9797   | 259     | 12 |
| 49 | 114     | 550     | .9782   | 245     | 11 |
| 50 | .45140  | .50587  | 1.9768  | .89232  | 10 |
| 51 | 166     | 623     | .9754   | 219     | 9  |
| 52 | 192     | 660     | .9740   | 206     | 8  |
| 53 | 218     | 696     | .9725   | 193     | 7  |
| 54 | 243     | 733     | .9711   | 180     | 6  |
| 55 | .45269  | .50769  | 1.9697  | .89167  | 5  |
| 56 | 295     | 806     | .9683   | 153     | 4  |
| 57 | 321     | 843     | .9669   | 140     | 3  |
| 58 | 347     | 879     | .9654   | 127     | 2  |
| 59 | 373     | 916     | .9640   | 114     | 1  |
| 60 | .45399  | .50953  | 1.9626  | .89101  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .45399  | .50953  | 1.9626  | .89101  | 60 |
| 1  | 425     | .50989  | .9612   | 087     | 59 |
| 2  | 451     | .51026  | .9598   | 074     | 58 |
| 3  | 477     | 063     | .9584   | 061     | 57 |
| 4  | 503     | 099     | .9570   | 048     | 56 |
| 5  | .45529  | .51136  | 1.9556  | .89053  | 55 |
| 6  | 554     | 173     | .9542   | 021     | 54 |
| 7  | 580     | 209     | .9528   | .89008  | 53 |
| 8  | 606     | 246     | .9514   | .88995  | 52 |
| 9  | 632     | 283     | .9500   | 981     | 51 |
| 10 | .45658  | .51319  | 1.9486  | .88968  | 50 |
| 11 | 684     | 356     | .9472   | 955     | 49 |
| 12 | 710     | 393     | .9458   | 942     | 48 |
| 13 | 736     | 430     | .9444   | 928     | 47 |
| 14 | 762     | 467     | .9430   | 915     | 46 |
| 15 | .45787  | .51503  | 1.9416  | .88902  | 45 |
| 16 | 813     | 540     | .9402   | 888     | 44 |
| 17 | 839     | 577     | .9388   | 875     | 43 |
| 18 | 865     | 614     | .9375   | 862     | 42 |
| 19 | 891     | 651     | .9361   | 848     | 41 |
| 20 | .45917  | .51688  | 1.9347  | .88835  | 40 |
| 21 | 942     | 724     | .9333   | 822     | 39 |
| 22 | 968     | 761     | .9319   | 808     | 38 |
| 23 | .45994  | 798     | .9306   | 795     | 37 |
| 24 | .46020  | 835     | .9292   | 782     | 36 |
| 25 | .46046  | .51872  | 1.9278  | .88768  | 35 |
| 26 | 072     | 909     | .9265   | 755     | 34 |
| 27 | 097     | 946     | .9251   | 741     | 33 |
| 28 | 123     | .51983  | .9237   | 728     | 32 |
| 29 | 149     | .52020  | .9223   | 715     | 31 |
| 30 | .46175  | .52057  | 1.9210  | .88701  | 30 |
| 31 | 201     | 094     | .9196   | 688     | 29 |
| 32 | 226     | 131     | .9183   | 674     | 28 |
| 33 | 252     | 168     | .9169   | 661     | 27 |
| 34 | 278     | 205     | .9155   | 647     | 26 |
| 35 | .46304  | .52242  | 1.9142  | .88634  | 25 |
| 36 | 330     | 279     | .9128   | 620     | 24 |
| 37 | 355     | 316     | .9115   | 607     | 23 |
| 38 | 381     | 353     | .9101   | 593     | 22 |
| 39 | 407     | 390     | .9088   | 580     | 21 |
| 40 | .46433  | .52427  | 1.9074  | .88566  | 20 |
| 41 | 458     | 464     | .9061   | 553     | 19 |
| 42 | 484     | 501     | .9047   | 539     | 18 |
| 43 | 510     | 538     | .9034   | 526     | 17 |
| 44 | 536     | 575     | .9020   | 512     | 16 |
| 45 | .46561  | .52613  | 1.9007  | .88499  | 15 |
| 46 | 587     | 650     | .8993   | 485     | 14 |
| 47 | 613     | 687     | .8980   | 472     | 13 |
| 48 | 639     | 724     | .8967   | 458     | 12 |
| 49 | 664     | 761     | .8953   | 445     | 11 |
| 50 | .46690  | .52798  | 1.8940  | .88431  | 10 |
| 51 | 716     | 836     | .8927   | 417     | 9  |
| 52 | 742     | 873     | .8913   | 404     | 8  |
| 53 | 767     | 910     | .8900   | 390     | 7  |
| 54 | 793     | 947     | .8887   | 377     | 6  |
| 55 | .46819  | .52985  | 1.8873  | .88363  | 5  |
| 56 | 844     | .53022  | .8860   | 349     | 4  |
| 57 | 870     | 059     | .8847   | 336     | 3  |
| 58 | 896     | 096     | .8834   | 322     | 2  |
| 59 | 921     | 134     | .8820   | 308     | 1  |
| 60 | .46947  | .53171  | 1.8807  | .88295  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

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|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .46947  | .53171  | 1.8807  | .88295  | 60 |
| 1  | .973    | 208     | .8794   | 281     | 59 |
| 2  | .46999  | 246     | .8781   | 267     | 58 |
| 3  | .47024  | 283     | .8768   | 254     | 57 |
| 4  | .030    | 320     | .8755   | 240     | 56 |
| 5  | .47076  | .53358  | 1.8741  | .88226  | 55 |
| 6  | 101     | 395     | .8728   | 213     | 54 |
| 7  | 127     | 432     | .8715   | 199     | 53 |
| 8  | 153     | 470     | .8702   | 185     | 52 |
| 9  | 178     | 507     | .8689   | 172     | 51 |
| 10 | .47204  | .53545  | 1.8676  | .88158  | 50 |
| 11 | 229     | 582     | .8663   | 144     | 49 |
| 12 | 255     | 620     | .8650   | 130     | 48 |
| 13 | 281     | 657     | .8637   | 117     | 47 |
| 14 | 306     | 694     | .8624   | 103     | 46 |
| 15 | .47332  | .53732  | 1.8611  | .88089  | 45 |
| 16 | 358     | 769     | .8598   | 075     | 44 |
| 17 | 383     | 807     | .8585   | 062     | 43 |
| 18 | 409     | 844     | .8572   | 048     | 42 |
| 19 | 434     | 882     | .8559   | 034     | 41 |
| 20 | .47460  | .53920  | 1.8546  | .88020  | 40 |
| 21 | 486     | 957     | .8533   | .88006  | 39 |
| 22 | 511     | .53995  | .8520   | .87993  | 38 |
| 23 | 537     | .54032  | .8507   | 979     | 37 |
| 24 | 562     | 070     | .8495   | 965     | 36 |
| 25 | .47588  | .54107  | 1.8482  | .87951  | 35 |
| 26 | 614     | 145     | .8469   | 937     | 34 |
| 27 | 639     | 183     | .8456   | 923     | 33 |
| 28 | 665     | 220     | .8443   | 909     | 32 |
| 29 | 690     | 258     | .8430   | 896     | 31 |
| 30 | .47716  | .54296  | 1.8418  | .87882  | 30 |
| 31 | 741     | 333     | .8405   | 868     | 29 |
| 32 | 767     | 371     | .8392   | 854     | 28 |
| 33 | 793     | 409     | .8379   | 840     | 27 |
| 34 | 818     | 446     | .8367   | 826     | 26 |
| 35 | .47844  | .54484  | 1.8354  | .87812  | 25 |
| 36 | 869     | 522     | .8341   | 798     | 24 |
| 37 | 895     | 560     | .8329   | 784     | 23 |
| 38 | 920     | 597     | .8316   | 770     | 22 |
| 39 | 946     | 635     | .8303   | 756     | 21 |
| 40 | .47971  | .54673  | 1.8291  | .87743  | 20 |
| 41 | .47997  | 711     | .8278   | 729     | 19 |
| 42 | .48022  | 748     | .8265   | 715     | 18 |
| 43 | 048     | 786     | .8253   | 701     | 17 |
| 44 | 073     | 824     | .8240   | 687     | 16 |
| 45 | .48099  | .54862  | 1.8228  | .87673  | 15 |
| 46 | 124     | 900     | .8215   | 659     | 14 |
| 47 | 150     | 938     | .8202   | 645     | 13 |
| 48 | 175     | .54975  | .8190   | 631     | 12 |
| 49 | 201     | .55013  | .8177   | 617     | 11 |
| 50 | .48226  | .55051  | 1.8165  | .87603  | 10 |
| 51 | 252     | 089     | .8152   | 589     | 9  |
| 52 | 277     | 127     | .8140   | 575     | 8  |
| 53 | 303     | 165     | .8127   | 561     | 7  |
| 54 | 328     | 203     | .8115   | 546     | 6  |
| 55 | .48354  | .55241  | 1.8103  | .87532  | 5  |
| 56 | 379     | 279     | .8090   | 518     | 4  |
| 57 | 405     | 317     | .8078   | 504     | 3  |
| 58 | 430     | 355     | .8065   | 490     | 2  |
| 59 | 456     | 393     | .8053   | 476     | 1  |
| 60 | .48481  | .55431  | 1.8040  | .87462  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .48481  | .55431  | 1.8040  | .87462  | 60 |
| 1  | 506     | 469     | .8028   | 448     | 59 |
| 2  | 532     | 507     | .8016   | 434     | 58 |
| 3  | 557     | 545     | .8003   | 420     | 57 |
| 4  | 583     | 583     | .7991   | 406     | 56 |
| 5  | .48608  | .55621  | 1.7979  | .87391  | 55 |
| 6  | 634     | 659     | .7966   | 377     | 54 |
| 7  | 659     | 697     | .7954   | 363     | 53 |
| 8  | 684     | 736     | .7942   | 349     | 52 |
| 9  | 710     | 774     | .7930   | 335     | 51 |
| 10 | .48735  | .55812  | 1.7917  | .87321  | 50 |
| 11 | 761     | 850     | .7905   | 306     | 49 |
| 12 | 786     | 888     | .7893   | 292     | 48 |
| 13 | 811     | 926     | .7881   | 278     | 47 |
| 14 | 837     | .55964  | .7868   | 264     | 46 |
| 15 | .48862  | .56003  | 1.7856  | .87250  | 45 |
| 16 | 888     | 041     | .7844   | 235     | 44 |
| 17 | 913     | 079     | .7832   | 221     | 43 |
| 18 | 938     | 117     | .7820   | 207     | 42 |
| 19 | 964     | 156     | .7808   | 193     | 41 |
| 20 | .48989  | .56194  | 1.7796  | .87178  | 40 |
| 21 | .49014  | 232     | .7783   | 164     | 39 |
| 22 | 040     | 270     | .7771   | 150     | 38 |
| 23 | 065     | 309     | .7759   | 136     | 37 |
| 24 | 090     | 347     | .7747   | 121     | 36 |
| 25 | .49116  | .56385  | 1.7735  | .87107  | 35 |
| 26 | 141     | 424     | .7723   | 093     | 34 |
| 27 | 166     | 462     | .7711   | 079     | 33 |
| 28 | 192     | 501     | .7699   | 064     | 32 |
| 29 | 217     | 539     | .7687   | 050     | 31 |
| 30 | .49242  | .56577  | 1.7675  | .87036  | 30 |
| 31 | 268     | 616     | .7663   | 021     | 29 |
| 32 | 293     | 654     | .7651   | .87007  | 28 |
| 33 | 318     | 693     | .7639   | .86993  | 27 |
| 34 | 344     | 731     | .7627   | 978     | 26 |
| 35 | .49369  | .56769  | 1.7615  | .86964  | 25 |
| 36 | 394     | 808     | .7603   | 949     | 24 |
| 37 | 419     | 846     | .7591   | 935     | 23 |
| 38 | 445     | 885     | .7579   | 921     | 22 |
| 39 | 470     | 923     | .7567   | 906     | 21 |
| 40 | .49495  | .56962  | 1.7556  | .86892  | 20 |
| 41 | 521     | .57000  | .7544   | 878     | 19 |
| 42 | 546     | 039     | .7532   | 863     | 18 |
| 43 | 571     | 078     | .7520   | 849     | 17 |
| 44 | 596     | 116     | .7508   | 834     | 16 |
| 45 | .49622  | .57153  | 1.7496  | .86820  | 15 |
| 46 | 647     | 193     | .7485   | 805     | 14 |
| 47 | 672     | 232     | .7473   | 791     | 13 |
| 48 | 697     | 271     | .7461   | 777     | 12 |
| 49 | 723     | 309     | .7449   | 762     | 11 |
| 50 | .49748  | .57348  | 1.7437  | .86748  | 10 |
| 51 | 773     | 386     | .7426   | 733     | 9  |
| 52 | 798     | 425     | .7414   | 719     | 8  |
| 53 | 824     | 464     | .7402   | 704     | 7  |
| 54 | 849     | 503     | .7391   | 690     | 6  |
| 55 | .49874  | .57541  | 1.7379  | .86675  | 5  |
| 56 | 899     | 580     | .7367   | 661     | 4  |
| 57 | 924     | 619     | .7355   | 646     | 3  |
| 58 | 950     | 657     | .7344   | 632     | 2  |
| 59 | .49975  | 696     | .7332   | 617     | 1  |
| 60 | .50000  | .57735  | 1.7321  | .86603  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .50000  | .57735  | 1.7321  | .86603  | 60 |
| 1  | .025    | .774    | .7309   | .588    | 59 |
| 2  | .050    | .813    | .7297   | .573    | 58 |
| 3  | .076    | .851    | .7286   | .559    | 57 |
| 4  | .101    | .890    | .7274   | .544    | 56 |
| 5  | .50126  | .57929  | 1.7262  | .86530  | 55 |
| 6  | .151    | .57968  | .7251   | .515    | 54 |
| 7  | .176    | .58007  | .7239   | .501    | 53 |
| 8  | .201    | .046    | .7228   | .486    | 52 |
| 9  | .227    | .085    | .7216   | .471    | 51 |
| 10 | .50252  | .58124  | 1.7205  | .86457  | 50 |
| 11 | .277    | .162    | .7193   | .442    | 49 |
| 12 | .302    | .201    | .7182   | .427    | 48 |
| 13 | .327    | .240    | .7170   | .413    | 47 |
| 14 | .352    | .279    | .7159   | .398    | 46 |
| 15 | .50377  | .58318  | 1.7147  | .86384  | 45 |
| 16 | .403    | .357    | .7136   | .369    | 44 |
| 17 | .428    | .396    | .7124   | .354    | 43 |
| 18 | .453    | .435    | .7113   | .340    | 42 |
| 19 | .478    | .474    | .7102   | .325    | 41 |
| 20 | .50503  | .58513  | 1.7090  | .86310  | 40 |
| 21 | .528    | .552    | .7079   | .295    | 39 |
| 22 | .553    | .591    | .7067   | .281    | 38 |
| 23 | .578    | .631    | .7056   | .266    | 37 |
| 24 | .603    | .670    | .7045   | .251    | 36 |
| 25 | .50628  | .58709  | 1.7033  | .86237  | 35 |
| 26 | .654    | .748    | .7022   | .222    | 34 |
| 27 | .679    | .787    | .7011   | .207    | 33 |
| 28 | .704    | .826    | .6999   | .192    | 32 |
| 29 | .729    | .865    | .6988   | .178    | 31 |
| 30 | .50754  | .58905  | 1.6977  | .86163  | 30 |
| 31 | .779    | .944    | .6965   | .148    | 29 |
| 32 | .804    | .58983  | .6954   | .133    | 28 |
| 33 | .829    | .59022  | .6943   | .119    | 27 |
| 34 | .854    | .061    | .6932   | .104    | 26 |
| 35 | .50879  | .59101  | 1.6920  | .86089  | 25 |
| 36 | .904    | .140    | .6909   | .074    | 24 |
| 37 | .929    | .179    | .6898   | .059    | 23 |
| 38 | .954    | .218    | .6887   | .045    | 22 |
| 39 | .50979  | .258    | .6875   | .030    | 21 |
| 40 | .51004  | .59297  | 1.6864  | .86015  | 20 |
| 41 | .029    | .336    | .6853   | .86000  | 19 |
| 42 | .054    | .376    | .6842   | .85985  | 18 |
| 43 | .079    | .415    | .6831   | .85970  | 17 |
| 44 | .104    | .454    | .6820   | .85956  | 16 |
| 45 | .51129  | .59494  | 1.6808  | .85941  | 15 |
| 46 | .154    | .533    | .6797   | .926    | 14 |
| 47 | .179    | .573    | .6786   | .911    | 13 |
| 48 | .204    | .612    | .6775   | .896    | 12 |
| 49 | .229    | .651    | .6764   | .881    | 11 |
| 50 | .51254  | .59691  | 1.6753  | .85866  | 10 |
| 51 | .279    | .730    | .6742   | .851    | 9  |
| 52 | .304    | .770    | .6731   | .836    | 8  |
| 53 | .329    | .809    | .6720   | .821    | 7  |
| 54 | .354    | .849    | .6709   | .806    | 6  |
| 55 | .51379  | .59888  | 1.6698  | .85792  | 5  |
| 56 | .404    | .928    | .6687   | .777    | 4  |
| 57 | .429    | .59967  | .6676   | .762    | 3  |
| 58 | .454    | .60007  | .6665   | .747    | 2  |
| 59 | .479    | .046    | .6654   | .732    | 1  |
| 60 | .51504  | .60086  | 1.6643  | .85717  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .51504  | .60086  | 1.6643  | .85717  | 60 |
| 1  | .529    | .126    | .6632   | .702    | 59 |
| 2  | .554    | .165    | .6621   | .687    | 58 |
| 3  | .579    | .205    | .6610   | .672    | 57 |
| 4  | .604    | .245    | .6599   | .657    | 56 |
| 5  | .51628  | .60284  | 1.6588  | .85642  | 55 |
| 6  | .653    | .324    | .6577   | .642    | 54 |
| 7  | .678    | .364    | .6566   | .612    | 53 |
| 8  | .703    | .403    | .6555   | .597    | 52 |
| 9  | .728    | .443    | .6545   | .582    | 51 |
| 10 | .51753  | .60483  | 1.6534  | .85567  | 50 |
| 11 | .778    | .522    | .6523   | .551    | 49 |
| 12 | .803    | .562    | .6512   | .536    | 48 |
| 13 | .828    | .602    | .6501   | .521    | 47 |
| 14 | .852    | .642    | .6490   | .506    | 46 |
| 15 | .51877  | .60681  | 1.6479  | .85491  | 45 |
| 16 | .902    | .721    | .6469   | .476    | 44 |
| 17 | .927    | .761    | .6458   | .461    | 43 |
| 18 | .952    | .801    | .6447   | .446    | 42 |
| 19 | .51977  | .841    | .6436   | .431    | 41 |
| 20 | .52002  | .60881  | 1.6426  | .85416  | 40 |
| 21 | .026    | .921    | .6415   | .401    | 39 |
| 22 | .051    | .60960  | .6404   | .385    | 38 |
| 23 | .076    | .61000  | .6393   | .370    | 37 |
| 24 | .101    | .040    | .6383   | .355    | 36 |
| 25 | .52126  | .61080  | 1.6372  | .85340  | 35 |
| 26 | .151    | .120    | .6361   | .325    | 34 |
| 27 | .175    | .160    | .6351   | .310    | 33 |
| 28 | .200    | .200    | .6340   | .294    | 32 |
| 29 | .225    | .240    | .6329   | .279    | 31 |
| 30 | .52250  | .61280  | 1.6319  | .85264  | 30 |
| 31 | .275    | .320    | .6308   | .249    | 29 |
| 32 | .299    | .360    | .6297   | .234    | 28 |
| 33 | .324    | .400    | .6287   | .218    | 27 |
| 34 | .349    | .440    | .6276   | .203    | 26 |
| 35 | .52374  | .61480  | 1.6265  | .85188  | 25 |
| 36 | .399    | .520    | .6255   | .173    | 24 |
| 37 | .423    | .561    | .6244   | .157    | 23 |
| 38 | .448    | .601    | .6234   | .142    | 22 |
| 39 | .473    | .641    | .6223   | .127    | 21 |
| 40 | .52498  | .61681  | 1.6212  | .85112  | 20 |
| 41 | .522    | .721    | .6202   | .096    | 19 |
| 42 | .547    | .761    | .6191   | .081    | 18 |
| 43 | .572    | .801    | .6181   | .066    | 17 |
| 44 | .597    | .842    | .6170   | .051    | 16 |
| 45 | .52621  | .61882  | 1.6160  | .85035  | 15 |
| 46 | .646    | .922    | .6149   | .020    | 14 |
| 47 | .671    | .61962  | .6139   | .85005  | 13 |
| 48 | .696    | .62003  | .6128   | .84989  | 12 |
| 49 | .720    | .043    | .6118   | .974    | 11 |
| 50 | .52745  | .62083  | 1.6107  | .84959  | 10 |
| 51 | .770    | .24     | .6097   | .943    | 9  |
| 52 | .794    | .164    | .6087   | .928    | 8  |
| 53 | .819    | .204    | .6076   | .913    | 7  |
| 54 | .844    | .245    | .6066   | .897    | 6  |
| 55 | .52869  | .62285  | 1.6055  | .84882  | 5  |
| 56 | .893    | .325    | .6045   | .866    | 4  |
| 57 | .918    | .366    | .6034   | .851    | 3  |
| 58 | .943    | .406    | .6024   | .836    | 2  |
| 59 | .967    | .446    | .6014   | .820    | 1  |
| 60 | .52992  | .62487  | 1.6003  | .84805  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .52992  | .62487  | 1.6003  | .84805  | 60 |
| 1  | .53017  | .62527  | .5993   | 789     | 59 |
| 2  | .53041  | .62568  | .5983   | 774     | 58 |
| 3  | .53066  | .62608  | .5972   | 759     | 57 |
| 4  | .53091  | .62649  | .5962   | 743     | 56 |
| 5  | .53115  | .62689  | 1.5952  | .84728  | 55 |
| 6  | .53140  | .62730  | .5941   | 712     | 54 |
| 7  | .53164  | .62770  | .5931   | 697     | 53 |
| 8  | .53189  | .62811  | .5921   | 681     | 52 |
| 9  | .53214  | .62852  | .5911   | 666     | 51 |
| 10 | .53238  | .62892  | 1.5900  | .84650  | 50 |
| 11 | .53263  | .62933  | .5890   | 635     | 49 |
| 12 | .53288  | .62973  | .5880   | 619     | 48 |
| 13 | .53312  | .63014  | .5869   | 604     | 47 |
| 14 | .53337  | .63055  | .5859   | 588     | 46 |
| 15 | .53361  | .63095  | 1.5849  | .84573  | 45 |
| 16 | .53386  | .63136  | .5839   | 557     | 44 |
| 17 | .53411  | .63177  | .5829   | 542     | 43 |
| 18 | .53435  | .63217  | .5818   | 526     | 42 |
| 19 | .53460  | .63258  | .5808   | 511     | 41 |
| 20 | .53484  | .63299  | 1.5798  | .84495  | 40 |
| 21 | .53509  | .63340  | .5788   | 480     | 39 |
| 22 | .53534  | .63380  | .5778   | 464     | 38 |
| 23 | .53558  | .63421  | .5768   | 448     | 37 |
| 24 | .53583  | .63462  | .5757   | 433     | 36 |
| 25 | .53607  | .63503  | 1.5747  | .84417  | 35 |
| 26 | .53632  | .63544  | .5737   | 402     | 34 |
| 27 | .53656  | .63584  | .5727   | 386     | 33 |
| 28 | .53681  | .63625  | .5717   | 370     | 32 |
| 29 | .53705  | .63666  | .5707   | 355     | 31 |
| 30 | .53730  | .63707  | 1.5697  | .84339  | 30 |
| 31 | .53754  | .63748  | .5687   | 324     | 29 |
| 32 | .53779  | .63789  | .5677   | 308     | 28 |
| 33 | .53804  | .63830  | .5667   | 292     | 27 |
| 34 | .53828  | .63871  | .5657   | 277     | 26 |
| 35 | .53853  | .63912  | 1.5647  | .84261  | 25 |
| 36 | .53877  | .63953  | .5637   | 245     | 24 |
| 37 | .53902  | .63994  | .5627   | 230     | 23 |
| 38 | .53926  | .64035  | .5617   | 214     | 22 |
| 39 | .53951  | .64076  | .5607   | 198     | 21 |
| 40 | .53975  | .64117  | 1.5597  | .84182  | 20 |
| 41 | .54000  | .64158  | .5587   | 167     | 19 |
| 42 | .54024  | .64199  | .5577   | 151     | 18 |
| 43 | .54049  | .64240  | .5567   | 135     | 17 |
| 44 | .54073  | .64281  | .5557   | 120     | 16 |
| 45 | .54097  | .64322  | 1.5547  | .84104  | 15 |
| 46 | .54122  | .64363  | .5537   | 088     | 14 |
| 47 | .54146  | .64404  | .5527   | 072     | 13 |
| 48 | .54171  | .64445  | .5517   | 057     | 12 |
| 49 | .54195  | .64487  | .5507   | 041     | 11 |
| 50 | .54220  | .64528  | 1.5497  | .84025  | 10 |
| 51 | .54244  | .64569  | .5487   | .84009  | 9  |
| 52 | .54269  | .64610  | .5477   | .83994  | 8  |
| 53 | .54293  | .64652  | .5468   | 978     | 7  |
| 54 | .54317  | .64693  | .5458   | 962     | 6  |
| 55 | .54342  | .64734  | 1.5448  | .83946  | 5  |
| 56 | .54366  | .64775  | .5438   | 930     | 4  |
| 57 | .54391  | .64817  | .5428   | 913     | 3  |
| 58 | .54415  | .64858  | .5418   | 899     | 2  |
| 59 | .54440  | .64899  | .5408   | 883     | 1  |
| 60 | .54464  | .64941  | 1.5399  | .83867  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .54464  | .64941  | 1.5399  | .83867  | 60 |
| 1  | .54488  | .64982  | .5389   | 851     | 59 |
| 2  | .54513  | .65024  | .5379   | 835     | 58 |
| 3  | .54537  | .65065  | .5369   | 819     | 57 |
| 4  | .54561  | .65106  | .5359   | 804     | 56 |
| 5  | .54586  | .65148  | 1.5350  | .83788  | 55 |
| 6  | .54610  | .65189  | .5340   | 772     | 54 |
| 7  | .54635  | .65231  | .5330   | 756     | 53 |
| 8  | .54659  | .65272  | .5320   | 740     | 52 |
| 9  | .54683  | .65314  | .5311   | 724     | 51 |
| 10 | .54708  | .65355  | 1.5301  | .83708  | 50 |
| 11 | .54732  | .65397  | .5291   | 692     | 49 |
| 12 | .54756  | .65438  | .5282   | 676     | 48 |
| 13 | .54781  | .65480  | .5272   | 660     | 47 |
| 14 | .54805  | .65521  | .5262   | 645     | 46 |
| 15 | .54829  | .65563  | 1.5253  | .83629  | 45 |
| 16 | .54854  | .65604  | .5243   | 613     | 44 |
| 17 | .54878  | .65646  | .5233   | 597     | 43 |
| 18 | .54902  | .65688  | .5224   | 581     | 42 |
| 19 | .54927  | .65729  | .5214   | 565     | 41 |
| 20 | .54951  | .65771  | 1.5204  | .83549  | 40 |
| 21 | .54975  | .65813  | .5195   | 533     | 39 |
| 22 | .54999  | .65854  | .5185   | 517     | 38 |
| 23 | .55024  | .65896  | .5175   | 501     | 37 |
| 24 | .55048  | .65938  | .5166   | 485     | 36 |
| 25 | .55072  | .65980  | 1.5156  | .83469  | 35 |
| 26 | .55097  | .66021  | .5147   | 453     | 34 |
| 27 | .55121  | .66063  | .5137   | 437     | 33 |
| 28 | .55145  | .66105  | .5127   | 421     | 32 |
| 29 | .55169  | .66147  | .5118   | 405     | 31 |
| 30 | .55194  | .66189  | 1.5108  | .83389  | 30 |
| 31 | .55218  | .66230  | .5099   | 373     | 29 |
| 32 | .55242  | .66272  | .5089   | 356     | 28 |
| 33 | .55266  | .66314  | .5080   | 340     | 27 |
| 34 | .55291  | .66356  | .5070   | 324     | 26 |
| 35 | .55315  | .66398  | 1.5061  | .83308  | 25 |
| 36 | .55339  | .66440  | .5051   | 292     | 24 |
| 37 | .55363  | .66482  | .5042   | 276     | 23 |
| 38 | .55388  | .66524  | .5032   | 260     | 22 |
| 39 | .55412  | .66566  | .5023   | 244     | 21 |
| 40 | .55436  | .66608  | 1.5013  | .83228  | 20 |
| 41 | .55460  | .66650  | .5004   | 212     | 19 |
| 42 | .55484  | .66692  | .4994   | 195     | 18 |
| 43 | .55509  | .66734  | .4985   | 179     | 17 |
| 44 | .55533  | .66776  | .4975   | 163     | 16 |
| 45 | .55557  | .66818  | 1.4966  | .83147  | 15 |
| 46 | .55581  | .66860  | .4957   | 131     | 14 |
| 47 | .55605  | .66902  | .4947   | 115     | 13 |
| 48 | .55630  | .66944  | .4938   | 098     | 12 |
| 49 | .55654  | .66986  | .4928   | 082     | 11 |
| 50 | .55678  | .67028  | 1.4919  | .83066  | 10 |
| 51 | .55702  | .67071  | .4910   | 050     | 9  |
| 52 | .55726  | .67113  | .4900   | 034     | 8  |
| 53 | .55750  | .67155  | .4891   | 017     | 7  |
| 54 | .55775  | .67197  | .4882   | .83001  | 6  |
| 55 | .55799  | .67239  | 1.4872  | .82985  | 5  |
| 56 | .55823  | .67282  | .4863   | 969     | 4  |
| 57 | .55847  | .67324  | .4854   | 953     | 3  |
| 58 | .55871  | .67366  | .4844   | 936     | 2  |
| 59 | .55895  | .67409  | .4835   | 920     | 1  |
| 60 | .55919  | .67451  | 1.4826  | .82904  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

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|                                 | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|---------------------------------|---------|---------|---------|---------|----|
| 0                               | .55919  | .67451  | 1.4826  | .82904  | 60 |
| 1                               | 943     | 493     | .4816   | 887     | 59 |
| 2                               | 968     | 536     | .4807   | 871     | 58 |
| 3                               | .55992  | 578     | .4798   | 855     | 57 |
| 4                               | .56016  | 620     | .4788   | 839     | 56 |
| 5                               | .56040  | .67663  | 1.4779  | .82822  | 55 |
| 6                               | 064     | 705     | .4770   | 806     | 54 |
| 7                               | 088     | 748     | .4761   | 790     | 53 |
| 8                               | 112     | 790     | .4751   | 773     | 52 |
| 9                               | 136     | 832     | .4742   | 757     | 51 |
| 10                              | .56160  | .67875  | 1.4733  | .82741  | 50 |
| 11                              | 184     | 917     | .4724   | 724     | 49 |
| 12                              | 208     | .67960  | .4715   | 708     | 48 |
| 13                              | 232     | .68002  | .4705   | 692     | 47 |
| 14                              | 256     | 045     | .4696   | 675     | 46 |
| 15                              | .56280  | .68088  | 1.4687  | .82659  | 45 |
| 16                              | 305     | 130     | .4678   | 643     | 44 |
| 17                              | 329     | 173     | .4669   | 626     | 43 |
| 18                              | 353     | 215     | .4659   | 610     | 42 |
| 19                              | 377     | 258     | .4650   | 593     | 41 |
| 20                              | .56401  | .68301  | 1.4641  | .82577  | 40 |
| 21                              | 425     | 343     | .4632   | 561     | 39 |
| 22                              | 449     | 386     | .4623   | 544     | 38 |
| 23                              | 473     | 429     | .4614   | 528     | 37 |
| 24                              | 497     | 471     | .4605   | 511     | 36 |
| 25                              | .56521  | .68514  | 1.4596  | .82495  | 35 |
| 26                              | 545     | 557     | .4586   | 478     | 34 |
| 27                              | 569     | 600     | .4577   | 462     | 33 |
| 28                              | 593     | 642     | .4568   | 446     | 32 |
| 29                              | 617     | 685     | .4559   | 429     | 31 |
| 30                              | .56641  | .68728  | 1.4550  | .82413  | 30 |
| 31                              | 665     | 771     | .4541   | 396     | 29 |
| 32                              | 689     | 814     | .4532   | 380     | 28 |
| 33                              | 713     | 857     | .4523   | 363     | 27 |
| 34                              | 736     | 900     | .4514   | 347     | 26 |
| 35                              | .56760  | .68942  | 1.4505  | .82330  | 25 |
| 36                              | 784     | .68985  | .4496   | 314     | 24 |
| 37                              | 808     | .69028  | .4487   | 297     | 23 |
| 38                              | 832     | 071     | .4478   | 281     | 22 |
| 39                              | 856     | 114     | .4469   | 264     | 21 |
| 40                              | .56880  | .69157  | 1.4460  | .82248  | 20 |
| 41                              | 904     | 200     | .4451   | 231     | 19 |
| 42                              | 928     | 243     | .4442   | 214     | 18 |
| 43                              | 952     | 286     | .4433   | 198     | 17 |
| 44                              | .56976  | 329     | .4424   | 181     | 16 |
| 45                              | .57000  | .69372  | 1.4415  | .82165  | 15 |
| 46                              | 024     | 416     | .4406   | 148     | 14 |
| 47                              | 047     | 459     | .4397   | 132     | 13 |
| 48                              | 071     | 502     | .4388   | 115     | 12 |
| 49                              | 095     | 545     | .4379   | 098     | 11 |
| 50                              | .57119  | .69588  | 1.4370  | .82082  | 10 |
| 51                              | 143     | 631     | .4361   | 065     | 9  |
| 52                              | 167     | 675     | .4352   | 048     | 8  |
| 53                              | 191     | 718     | .4344   | 032     | 7  |
| 54                              | 215     | 761     | .4335   | .82015  | 6  |
| 55                              | .57238  | .69804  | 1.4326  | .81999  | 5  |
| 56                              | 262     | 847     | .4317   | 982     | 4  |
| 57                              | 286     | 891     | .4308   | 965     | 3  |
| 58                              | 310     | 934     | .4299   | 949     | 2  |
| 59                              | 334     | .69977  | .4290   | 932     | 1  |
| 60                              | .57358  | .70021  | 1.4281  | .81915  | 0  |
| N. Cos. N. Cot. N. Tan. N. Sin. |         |         |         |         |    |

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|                                 | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|---------------------------------|---------|---------|---------|---------|----|
| 0                               | .57358  | .70021  | 1.4281  | .81915  | 60 |
| 1                               | 381     | 064     | .4273   | 899     | 59 |
| 2                               | 405     | 107     | .4264   | 882     | 58 |
| 3                               | 429     | 151     | .4255   | 865     | 57 |
| 4                               | 453     | 194     | .4246   | 848     | 56 |
| 5                               | .57477  | .70238  | 1.4237  | .81832  | 55 |
| 6                               | 501     | 281     | .4229   | 815     | 54 |
| 7                               | 524     | 325     | .4220   | 798     | 53 |
| 8                               | 548     | 368     | .4211   | 782     | 52 |
| 9                               | 572     | 412     | .4202   | 765     | 51 |
| 10                              | .57596  | .70455  | 1.4193  | .81748  | 50 |
| 11                              | 619     | 499     | .4185   | 731     | 49 |
| 12                              | 643     | 542     | .4176   | 714     | 48 |
| 13                              | 667     | 586     | .4167   | 698     | 47 |
| 14                              | 691     | 629     | .4158   | 681     | 46 |
| 15                              | .57715  | .70673  | 1.4150  | .81664  | 45 |
| 16                              | 738     | 717     | .4141   | 647     | 44 |
| 17                              | 762     | 760     | .4132   | 631     | 43 |
| 18                              | 786     | 804     | .4124   | 614     | 42 |
| 19                              | 810     | 848     | .4115   | 597     | 41 |
| 20                              | .57833  | .70891  | 1.4106  | .81580  | 40 |
| 21                              | 857     | 935     | .4097   | 563     | 39 |
| 22                              | 881     | .70979  | .4089   | 546     | 38 |
| 23                              | 904     | .71023  | .4080   | 530     | 37 |
| 24                              | 928     | 066     | .4071   | 513     | 36 |
| 25                              | .57952  | .71110  | 1.4063  | .81496  | 35 |
| 26                              | 976     | 154     | .4054   | 479     | 34 |
| 27                              | .57999  | 198     | .4045   | 462     | 33 |
| 28                              | .58023  | 242     | .4037   | 445     | 32 |
| 29                              | 047     | 285     | .4028   | 428     | 31 |
| 30                              | .58070  | .71329  | 1.4019  | .81412  | 30 |
| 31                              | 094     | 373     | .4011   | 395     | 29 |
| 32                              | 118     | 417     | .4002   | 378     | 28 |
| 33                              | 141     | 461     | .3994   | 361     | 27 |
| 34                              | 165     | 505     | .3985   | 344     | 26 |
| 35                              | .58189  | .71549  | 1.3976  | .81327  | 25 |
| 36                              | 212     | 593     | .3968   | 310     | 24 |
| 37                              | 236     | 637     | .3959   | 293     | 23 |
| 38                              | 260     | 681     | .3951   | 276     | 22 |
| 39                              | 283     | 725     | .3942   | 259     | 21 |
| 40                              | .58307  | .71769  | 1.3934  | .81242  | 20 |
| 41                              | 330     | 813     | .3925   | 225     | 19 |
| 42                              | 354     | 857     | .3916   | 208     | 18 |
| 43                              | 378     | 901     | .3908   | 191     | 17 |
| 44                              | 401     | 946     | .3899   | 174     | 16 |
| 45                              | .58425  | .71990  | 1.3891  | .81157  | 15 |
| 46                              | 449     | .72034  | .3882   | 140     | 14 |
| 47                              | 472     | 078     | .3874   | 123     | 13 |
| 48                              | 496     | 122     | .3865   | 106     | 12 |
| 49                              | 519     | 167     | .3857   | 089     | 11 |
| 50                              | .58543  | .72211  | 1.3848  | .81072  | 10 |
| 51                              | 567     | 255     | .3840   | 055     | 9  |
| 52                              | 590     | 299     | .3831   | 038     | 8  |
| 53                              | 614     | 344     | .3823   | 021     | 7  |
| 54                              | 637     | 388     | .3814   | .81004  | 6  |
| 55                              | .58661  | .72432  | 1.3806  | .80987  | 5  |
| 56                              | 684     | 477     | .3798   | 970     | 4  |
| 57                              | 708     | 521     | .3789   | 953     | 3  |
| 58                              | 731     | 565     | .3781   | 936     | 2  |
| 59                              | 755     | 610     | .3772   | 919     | 1  |
| 60                              | .58779  | .72654  | 1.3764  | .80902  | 0  |
| N. Cos. N. Cot. N. Tan. N. Sin. |         |         |         |         |    |



|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .58779  | .72654  | 1.3764  | .80902  | 60 |
| 1  | 802     | 699     | .3755   | 885     | 59 |
| 2  | 826     | 743     | .3747   | 867     | 58 |
| 3  | 849     | 788     | .3739   | 850     | 57 |
| 4  | 873     | 832     | .3730   | 833     | 56 |
| 5  | .58896  | .72877  | 1.3722  | .80816  | 55 |
| 6  | 920     | 921     | .3713   | 799     | 54 |
| 7  | 943     | .72966  | .3705   | 782     | 53 |
| 8  | 967     | .73010  | .3697   | 765     | 52 |
| 9  | .58990  | 055     | .3688   | 748     | 51 |
| 10 | .59014  | .73100  | 1.3680  | .80730  | 50 |
| 11 | 037     | 144     | .3672   | 713     | 49 |
| 12 | 061     | 189     | .3663   | 696     | 48 |
| 13 | 084     | 234     | .3655   | 679     | 47 |
| 14 | 108     | 278     | .3647   | 662     | 46 |
| 15 | .59131  | .73323  | 1.3638  | .80644  | 45 |
| 16 | 154     | 368     | .3630   | 627     | 44 |
| 17 | 178     | 413     | .3622   | 610     | 43 |
| 18 | 201     | 457     | .3613   | 593     | 42 |
| 19 | 225     | 502     | .3605   | 576     | 41 |
| 20 | .59248  | .73547  | 1.3597  | .80558  | 40 |
| 21 | 272     | 592     | .3588   | 541     | 39 |
| 22 | 295     | 637     | .3580   | 524     | 38 |
| 23 | 318     | 681     | .3572   | 507     | 37 |
| 24 | 342     | 726     | .3564   | 489     | 36 |
| 25 | .59365  | .73771  | 1.3555  | .80472  | 35 |
| 26 | 389     | 816     | .3547   | 453     | 34 |
| 27 | 412     | 861     | .3539   | 438     | 33 |
| 28 | 436     | 906     | .3531   | 420     | 32 |
| 29 | 459     | 951     | .3522   | 403     | 31 |
| 30 | .59482  | .73996  | 1.3514  | .80386  | 30 |
| 31 | 506     | .74041  | .3506   | 368     | 29 |
| 32 | 529     | 086     | .3498   | 351     | 28 |
| 33 | 552     | 131     | .3490   | 334     | 27 |
| 34 | 576     | 176     | .3481   | 316     | 26 |
| 35 | .59599  | .74221  | 1.3473  | .80299  | 25 |
| 36 | 622     | 267     | .3465   | 282     | 24 |
| 37 | 646     | 312     | .3457   | 264     | 23 |
| 38 | 669     | 357     | .3449   | 247     | 22 |
| 39 | 693     | 402     | .3440   | 230     | 21 |
| 40 | .59716  | .74447  | 1.3432  | .80212  | 20 |
| 41 | 739     | 492     | .3424   | 195     | 19 |
| 42 | 763     | 538     | .3416   | 178     | 18 |
| 43 | 786     | 583     | .3408   | 160     | 17 |
| 44 | 809     | 628     | .3400   | 143     | 16 |
| 45 | .59832  | .74674  | 1.3392  | .80125  | 15 |
| 46 | 856     | 719     | .3384   | 108     | 14 |
| 47 | 879     | 764     | .3375   | 091     | 13 |
| 48 | 902     | 810     | .3367   | 073     | 12 |
| 49 | 926     | 855     | .3359   | 056     | 11 |
| 50 | .59949  | .74900  | 1.3351  | .80038  | 10 |
| 51 | 972     | 946     | .3343   | 021     | 9  |
| 52 | .59995  | .74991  | .3335   | .80003  | 8  |
| 53 | .60019  | .75037  | .3327   | .79986  | 7  |
| 54 | 042     | 082     | .3319   | 968     | 6  |
| 55 | .60065  | .75128  | 1.3311  | .79951  | 5  |
| 56 | 089     | 173     | .3303   | 934     | 4  |
| 57 | 112     | 219     | .3295   | 916     | 3  |
| 58 | 135     | 264     | .3287   | 899     | 2  |
| 59 | 158     | 310     | .3278   | 881     | 1  |
| 60 | .60182  | .75355  | 1.3270  | .79864  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .60182  | .75355  | 1.3270  | .79864  | 60 |
| 1  | 205     | 401     | .3262   | 846     | 59 |
| 2  | 228     | 447     | .3254   | 829     | 58 |
| 3  | 251     | 492     | .3246   | 811     | 57 |
| 4  | 274     | 538     | .3238   | 793     | 56 |
| 5  | .60298  | .75584  | 1.3230  | .79776  | 55 |
| 6  | 321     | 629     | .3222   | 775     | 54 |
| 7  | 344     | 675     | .3214   | 741     | 53 |
| 8  | 367     | 721     | .3206   | 723     | 52 |
| 9  | 390     | 767     | .3198   | 706     | 51 |
| 10 | .60414  | .75812  | 1.3190  | .79688  | 50 |
| 11 | 437     | 858     | .3182   | 671     | 49 |
| 12 | 460     | 904     | .3175   | 653     | 48 |
| 13 | 483     | 950     | .3167   | 635     | 47 |
| 14 | 506     | .75996  | .3159   | 618     | 46 |
| 15 | .60529  | .76042  | 1.3151  | .79600  | 45 |
| 16 | 553     | 088     | .3143   | 583     | 44 |
| 17 | 576     | 134     | .3135   | 565     | 43 |
| 18 | 599     | 180     | .3127   | 547     | 42 |
| 19 | 622     | 226     | .3119   | 530     | 41 |
| 20 | .60645  | .76272  | 1.3111  | .79512  | 40 |
| 21 | 668     | 318     | .3103   | 494     | 39 |
| 22 | 691     | 364     | .3095   | 477     | 38 |
| 23 | 714     | 410     | .3087   | 459     | 37 |
| 24 | 738     | 456     | .3079   | 441     | 36 |
| 25 | .60761  | .76502  | 1.3072  | .79424  | 35 |
| 26 | 784     | 548     | .3064   | 406     | 34 |
| 27 | 807     | 594     | .3056   | 388     | 33 |
| 28 | 830     | 640     | .3048   | 371     | 32 |
| 29 | 853     | 686     | .3040   | 353     | 31 |
| 30 | .60876  | .76733  | 1.3032  | .79335  | 30 |
| 31 | 899     | 779     | .3024   | 318     | 29 |
| 32 | 922     | 825     | .3017   | 300     | 28 |
| 33 | 945     | 871     | .3009   | 282     | 27 |
| 34 | 968     | 918     | .3001   | 264     | 26 |
| 35 | .60991  | .76964  | 1.2993  | .79247  | 25 |
| 36 | .61015  | .77010  | .2985   | 229     | 24 |
| 37 | 038     | 057     | .2977   | 211     | 23 |
| 38 | 061     | 103     | .2970   | 193     | 22 |
| 39 | 084     | 149     | .2962   | 176     | 21 |
| 40 | .61107  | .77196  | 1.2954  | .79158  | 20 |
| 41 | 130     | 242     | .2946   | 140     | 19 |
| 42 | 153     | 289     | .2938   | 122     | 18 |
| 43 | 176     | 335     | .2931   | 105     | 17 |
| 44 | 199     | 382     | .2923   | 087     | 16 |
| 45 | .61222  | .77428  | 1.2915  | .79069  | 15 |
| 46 | 245     | 475     | .2907   | 051     | 14 |
| 47 | 268     | 521     | .2900   | 033     | 13 |
| 48 | 291     | 568     | .2892   | .79016  | 12 |
| 49 | 314     | 615     | .2884   | .78998  | 11 |
| 50 | .61337  | .77661  | 1.2876  | .78980  | 10 |
| 51 | 360     | 708     | .2869   | 962     | 9  |
| 52 | 383     | 754     | .2861   | 944     | 8  |
| 53 | 406     | 801     | .2853   | 926     | 7  |
| 54 | 429     | 848     | .2846   | 908     | 6  |
| 55 | .61451  | .77895  | 1.2838  | .78891  | 5  |
| 56 | 474     | 941     | .2830   | 873     | 4  |
| 57 | 497     | .77988  | .2822   | 855     | 3  |
| 58 | 520     | .78035  | .2815   | 837     | 2  |
| 59 | 543     | 082     | .2807   | 819     | 1  |
| 60 | .61566  | .78129  | 1.2799  | .78801  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

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|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .61566  | .78129  | 1.2799  | .78801  | 60 |
| 1  | 589     | 175     | .2792   | 783     | 59 |
| 2  | 612     | 222     | .2784   | 765     | 58 |
| 3  | 635     | 269     | .2776   | 747     | 57 |
| 4  | 658     | 316     | .2769   | 729     | 56 |
| 5  | .61681  | .78363  | 1.2761  | .78711  | 55 |
| 6  | 704     | 410     | .2753   | 694     | 54 |
| 7  | 726     | 457     | .2746   | 676     | 53 |
| 8  | 749     | 504     | .2738   | 658     | 52 |
| 9  | 772     | 551     | .2731   | 640     | 51 |
| 10 | .61795  | .78598  | 1.2723  | .78622  | 50 |
| 11 | 818     | 645     | .2715   | 604     | 49 |
| 12 | 841     | 692     | .2708   | 586     | 48 |
| 13 | 864     | 739     | .2700   | 568     | 47 |
| 14 | 887     | 786     | .2693   | 550     | 46 |
| 15 | .61909  | .78834  | 1.2685  | .78532  | 45 |
| 16 | 932     | 881     | .2677   | 514     | 44 |
| 17 | 955     | 928     | .2670   | 496     | 43 |
| 18 | .61978  | .78975  | .2662   | 478     | 42 |
| 19 | .62001  | .79022  | .2655   | 460     | 41 |
| 20 | .62024  | .79070  | 1.2647  | .78442  | 40 |
| 21 | 046     | 117     | .2640   | 424     | 39 |
| 22 | 069     | 164     | .2632   | 405     | 38 |
| 23 | 092     | 212     | .2624   | 387     | 37 |
| 24 | 115     | 259     | .2617   | 369     | 36 |
| 25 | .62138  | .79306  | 1.2609  | .78351  | 35 |
| 26 | 160     | 354     | .2602   | 333     | 34 |
| 27 | 183     | 401     | .2594   | 315     | 33 |
| 28 | 206     | 449     | .2587   | 297     | 32 |
| 29 | 229     | 496     | .2579   | 279     | 31 |
| 30 | .62251  | .79544  | 1.2572  | .78261  | 30 |
| 31 | 274     | 591     | .2564   | 243     | 29 |
| 32 | 297     | 639     | .2557   | 225     | 28 |
| 33 | 320     | 686     | .2549   | 206     | 27 |
| 34 | 342     | 734     | .2542   | 188     | 26 |
| 35 | .62365  | .79781  | 1.2534  | .78170  | 25 |
| 36 | 388     | 829     | .2527   | 152     | 24 |
| 37 | 411     | 877     | .2519   | 134     | 23 |
| 38 | 433     | 924     | .2512   | 116     | 22 |
| 39 | 456     | .79972  | .2504   | 098     | 21 |
| 40 | .62479  | .80020  | 1.2497  | .78079  | 20 |
| 41 | 502     | 067     | .2489   | 061     | 19 |
| 42 | 524     | 115     | .2482   | 043     | 18 |
| 43 | 547     | 163     | .2475   | 025     | 17 |
| 44 | 570     | 211     | .2467   | .78007  | 16 |
| 45 | .62592  | .80258  | 1.2460  | .77988  | 15 |
| 46 | 615     | 306     | .2452   | 970     | 14 |
| 47 | 638     | 354     | .2445   | 952     | 13 |
| 48 | 660     | 402     | .2437   | 934     | 12 |
| 49 | 683     | 450     | .2430   | 916     | 11 |
| 50 | .62706  | .80498  | 1.2423  | .77897  | 10 |
| 51 | 728     | 546     | .2415   | 879     | 9  |
| 52 | 751     | 594     | .2408   | 861     | 8  |
| 53 | 774     | 642     | .2401   | 843     | 7  |
| 54 | 796     | 690     | .2393   | 824     | 6  |
| 55 | .62819  | .80738  | 1.2386  | .77806  | 5  |
| 56 | 842     | 786     | .2378   | 788     | 4  |
| 57 | 864     | 834     | .2371   | 769     | 3  |
| 58 | 887     | 882     | .2364   | 751     | 2  |
| 59 | 909     | 930     | .2356   | 733     | 1  |
| 60 | .62932  | .80978  | 1.2349  | .77715  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

K1°

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|    | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|----|---------|---------|---------|---------|----|
| 0  | .62932  | .80978  | 1.2349  | .77715  | 60 |
| 1  | 955     | .81027  | .2342   | 696     | 59 |
| 2  | .62977  | 075     | .2334   | 678     | 58 |
| 3  | .63000  | 123     | .2327   | 660     | 57 |
| 4  | 022     | 171     | .2320   | 641     | 56 |
| 5  | .63045  | .81220  | 1.2312  | .77623  | 55 |
| 6  | 068     | 268     | .2305   | 605     | 54 |
| 7  | 090     | 316     | .2298   | 586     | 53 |
| 8  | 113     | 364     | .2290   | 568     | 52 |
| 9  | 135     | 413     | .2283   | 550     | 51 |
| 10 | .63158  | .81461  | 1.2276  | .77531  | 50 |
| 11 | 180     | 510     | .2268   | 513     | 49 |
| 12 | 203     | 558     | .2261   | 494     | 48 |
| 13 | 225     | 606     | .2254   | 476     | 47 |
| 14 | 248     | 655     | .2247   | 458     | 46 |
| 15 | .63271  | .81703  | 1.2239  | .77439  | 45 |
| 16 | 293     | 752     | .2232   | 421     | 44 |
| 17 | 316     | 800     | .2225   | 402     | 43 |
| 18 | 338     | 849     | .2218   | 384     | 42 |
| 19 | 361     | 898     | .2210   | 366     | 41 |
| 20 | .63383  | .81946  | 1.2203  | .77347  | 40 |
| 21 | 406     | .81995  | .2196   | 329     | 39 |
| 22 | 428     | .82044  | .2189   | 310     | 38 |
| 23 | 451     | 092     | .2181   | 292     | 37 |
| 24 | 473     | 141     | .2174   | 273     | 36 |
| 25 | .63496  | .82190  | 1.2167  | .77253  | 35 |
| 26 | 518     | 238     | .2160   | 236     | 34 |
| 27 | 540     | 287     | .2153   | 218     | 33 |
| 28 | 563     | 336     | .2145   | 199     | 32 |
| 29 | 585     | 385     | .2138   | 181     | 31 |
| 30 | .63608  | .82434  | 1.2131  | .77162  | 30 |
| 31 | 630     | 483     | .2124   | 144     | 29 |
| 32 | 653     | 531     | .2117   | 125     | 28 |
| 33 | 675     | 580     | .2109   | 107     | 27 |
| 34 | 698     | 629     | .2102   | 088     | 26 |
| 35 | .63720  | .82678  | 1.2095  | .77070  | 25 |
| 36 | 742     | 727     | .2088   | 051     | 24 |
| 37 | 765     | 776     | .2081   | 033     | 23 |
| 38 | 787     | 825     | .2074   | .77014  | 22 |
| 39 | 810     | 874     | .2066   | .76996  | 21 |
| 40 | .63832  | .82923  | 1.2059  | .76977  | 20 |
| 41 | 854     | .82972  | .2052   | 959     | 19 |
| 42 | 877     | .83022  | .2045   | 940     | 18 |
| 43 | 899     | 071     | .2038   | 921     | 17 |
| 44 | 922     | 120     | .2031   | 903     | 16 |
| 45 | .63944  | .83169  | 1.2024  | .76884  | 15 |
| 46 | 966     | 218     | .2017   | 866     | 14 |
| 47 | .63989  | 268     | .2009   | 847     | 13 |
| 48 | .64011  | 317     | .2002   | 828     | 12 |
| 49 | 033     | 366     | .1995   | 810     | 11 |
| 50 | .64056  | .83415  | 1.1988  | .76791  | 10 |
| 51 | 078     | 465     | .1981   | 772     | 9  |
| 52 | 100     | 514     | .1974   | 754     | 8  |
| 53 | 123     | 564     | .1967   | 735     | 7  |
| 54 | 145     | 613     | .1960   | 717     | 6  |
| 55 | .64167  | .83662  | 1.1953  | .76698  | 5  |
| 56 | 190     | 712     | .1946   | 679     | 4  |
| 57 | 212     | 761     | .1939   | 661     | 3  |
| 58 | 234     | 811     | .1932   | 642     | 2  |
| 59 | 256     | 860     | .1925   | 623     | 1  |
| 60 | .64279  | .83910  | 1.1918  | .76604  | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. |    |

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|           | N. Sin. | N. Tan. | N. Cot. | N. Cos. |           |
|-----------|---------|---------|---------|---------|-----------|
|           | .64279  | .83910  | 1.1918  | .76604  | <b>60</b> |
|           | 301     | .83960  | .1910   | 586     | 59        |
|           | 32      | .84009  | .1903   | 567     | 58        |
|           | 346     | .059    | .1896   | 548     | 57        |
| 4         | 368     | .108    | .1889   | 530     | 56        |
| 5         | .64390  | .84158  | 1.1882  | .76511  | 55        |
| 6         | 412     | .208    | .1875   | 492     | 54        |
| 7         | 433     | .258    | .1868   | 473     | 53        |
| 8         | 457     | .307    | .1861   | 455     | 52        |
| 9         | 479     | .357    | .1854   | 439     | 51        |
| <b>10</b> | .64501  | .84407  | 1.1847  | .76417  | <b>50</b> |
| 11        | 524     | .457    | .1840   | 398     | 49        |
| 12        | 546     | .507    | .1833   | 380     | 48        |
| 13        | 568     | .556    | .1826   | 361     | 47        |
| 14        | 590     | .606    | .1819   | 342     | 46        |
| 15        | .64612  | .84656  | 1.1812  | .76323  | 45        |
| 16        | 635     | .706    | .1806   | 304     | 44        |
| 17        | 657     | .756    | .1799   | 286     | 43        |
| 18        | 679     | .806    | .1792   | 267     | 42        |
| 19        | 701     | .856    | .1785   | 248     | 41        |
| <b>20</b> | .64723  | .84906  | 1.1778  | .76229  | <b>40</b> |
| 21        | 746     | .84956  | .1771   | 210     | 39        |
| 22        | 768     | .85006  | .1764   | 192     | 38        |
| 23        | 790     | .057    | .1757   | 173     | 37        |
| 24        | 812     | .107    | .1750   | 154     | 36        |
| 25        | .64834  | .85157  | 1.1743  | .76135  | 35        |
| 26        | 856     | .207    | .1736   | 116     | 34        |
| 27        | 878     | .257    | .1729   | 97      | 33        |
| 28        | 901     | .308    | .1722   | 78      | 32        |
| 29        | 923     | .358    | .1715   | 59      | 31        |
| <b>30</b> | .64945  | .85408  | 1.1708  | .76041  | <b>30</b> |
| 31        | 967     | .458    | .1702   | 222     | 29        |
| 32        | .64989  | .85458  | .1695   | .76003  | 28        |
| 33        | .65011  | .559    | .1688   | .75984  | 27        |
| 34        | .033    | .609    | .1681   | 965     | 26        |
| 35        | .65055  | .85660  | 1.1674  | .75946  | 25        |
| 36        | 077     | .710    | .1667   | 927     | 24        |
| 37        | 100     | .761    | .1660   | 908     | 23        |
| 38        | 122     | .811    | .1653   | 889     | 22        |
| 39        | 144     | .862    | .1647   | 870     | 21        |
| <b>40</b> | .65166  | .85912  | 1.1640  | .75851  | <b>20</b> |
| 41        | 188     | .85963  | .1633   | 832     | 19        |
| 42        | 210     | .86014  | .1626   | 813     | 18        |
| 43        | 232     | .064    | .1619   | 794     | 17        |
| 44        | 254     | .113    | .1612   | 775     | 16        |
| 45        | .65276  | .86166  | 1.1606  | .75756  | 15        |
| 46        | 298     | .216    | .1599   | 738     | 14        |
| 47        | 320     | .267    | .1592   | 719     | 13        |
| 48        | 342     | .318    | .1585   | 700     | 12        |
| 49        | 364     | .368    | .1578   | 680     | 11        |
| <b>50</b> | .65386  | .86419  | 1.1571  | .75661  | <b>10</b> |
| 51        | 408     | .470    | .1565   | 642     | 9         |
| 52        | 430     | .521    | .1558   | 623     | 8         |
| 53        | 452     | .572    | .1551   | 604     | 7         |
| 54        | 474     | .623    | .1544   | 585     | 6         |
| 55        | .65496  | .86674  | 1.1538  | .75566  | 5         |
| 56        | 518     | .725    | .1531   | 547     | 4         |
| 57        | 540     | .776    | .1524   | 528     | 3         |
| 58        | 562     | .827    | .1517   | 509     | 2         |
| 59        | 584     | .878    | .1510   | 490     | 1         |
| <b>60</b> | .65606  | .86929  | 1.1504  | .75471  | <b>0</b>  |
|           | N. Cos. | N. Cot. | N. Tan. | N. Sin. |           |

|           | N. Sin. | N. Tan. | N. Cot. | N. Cos. |           |
|-----------|---------|---------|---------|---------|-----------|
| <b>0</b>  | .65606  | .86929  | 1.1504  | .75471  | <b>60</b> |
| 1         | 628     | .86980  | .1497   | 452     | 59        |
| 2         | 650     | .87031  | .1490   | 433     | 58        |
| 3         | 672     | .082    | .1483   | 414     | 57        |
| 4         | 694     | .133    | .1477   | 395     | 56        |
| 5         | .65716  | .87184  | 1.1470  | .75375  | 55        |
| 6         | 738     | .236    | .1463   | 356     | 54        |
| 7         | 759     | .287    | .1456   | 337     | 53        |
| 8         | 781     | .338    | .1450   | 318     | 52        |
| 9         | 803     | .389    | .1443   | 299     | 51        |
| <b>10</b> | .65825  | .87441  | 1.1436  | .75280  | <b>50</b> |
| 11        | 847     | .492    | .1430   | 261     | 49        |
| 12        | 869     | .543    | .1423   | 241     | 48        |
| 13        | 891     | .595    | .1416   | 222     | 47        |
| 14        | 913     | .646    | .1410   | 203     | 46        |
| 15        | .65935  | .87698  | 1.1403  | .75184  | 45        |
| 16        | 956     | .749    | .1396   | 165     | 44        |
| 17        | .65978  | .801    | .1389   | 146     | 43        |
| 18        | .66000  | .852    | .1383   | 126     | 42        |
| 19        | 922     | .904    | .1376   | 107     | 41        |
| <b>20</b> | .66044  | .87955  | 1.1369  | .75088  | <b>40</b> |
| 21        | 966     | .88007  | .1363   | 969     | 39        |
| 22        | 988     | .059    | .1356   | 950     | 38        |
| 23        | 109     | .110    | .1349   | 930     | 37        |
| 24        | 131     | .162    | .1343   | .75011  | 36        |
| 25        | .66153  | .88214  | 1.1336  | .74992  | 35        |
| 26        | 173     | .265    | .1329   | 973     | 34        |
| 27        | 197     | .317    | .1323   | 953     | 33        |
| 28        | 218     | .369    | .1316   | 934     | 32        |
| 29        | 240     | .421    | .1310   | 915     | 31        |
| <b>30</b> | .66262  | .88473  | 1.1303  | .74896  | <b>30</b> |
| 31        | 282     | .524    | .1296   | 876     | 29        |
| 32        | 306     | .576    | .1290   | 857     | 28        |
| 33        | 327     | .628    | .1283   | 838     | 27        |
| 34        | 349     | .680    | .1276   | 818     | 26        |
| 35        | .66371  | .88732  | 1.1270  | .74799  | 25        |
| 36        | 393     | .784    | .1263   | 780     | 24        |
| 37        | 414     | .836    | .1257   | 760     | 23        |
| 38        | 436     | .888    | .1250   | 741     | 22        |
| 39        | 458     | .940    | .1243   | 722     | 21        |
| <b>40</b> | .66480  | .88992  | 1.1237  | .74703  | <b>20</b> |
| 41        | 501     | .89045  | .1230   | 683     | 19        |
| 42        | 523     | .097    | .1224   | 664     | 18        |
| 43        | 545     | .149    | .1217   | 644     | 17        |
| 44        | 566     | .201    | .1211   | 625     | 16        |
| 45        | .66588  | .89253  | 1.1204  | .74606  | 15        |
| 46        | 610     | .306    | .1197   | 586     | 14        |
| 47        | 632     | .358    | .1191   | 567     | 13        |
| 48        | 653     | .410    | .1184   | 548     | 12        |
| 49        | 675     | .463    | .1178   | 528     | 11        |
| <b>50</b> | .66697  | .89515  | 1.1171  | .74509  | <b>10</b> |
| 51        | 718     | .567    | .1166   | 489     | 9         |
| 52        | 740     | .620    | .1158   | 470     | 8         |
| 53        | 762     | .672    | .1152   | 451     | 7         |
| 54        | 783     | .725    | .1145   | 431     | 6         |
| 55        | .66805  | .89777  | 1.1139  | .74412  | 5         |
| 56        | 827     | .830    | .1132   | 392     | 4         |
| 57        | 848     | .883    | .1126   | 373     | 3         |
| 58        | 870     | .935    | .1119   | 353     | 2         |
| 59        | 891     | .89988  | .1113   | 334     | 1         |
| <b>60</b> | .66913  | .90040  | 1.1106  | .74314  | <b>0</b>  |
|           | N. Cos. | N. Cot. | N. Tan. | N. Sin. |           |

|                                 | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|---------------------------------|---------|---------|---------|---------|----|
| 0                               | .66913  | .90040  | 1.1106  | .74314  | 60 |
| 1                               | .935    | .093    | 1.100   | .295    | 59 |
| 2                               | .956    | .146    | 1.093   | .276    | 58 |
| 3                               | .978    | .199    | 1.087   | .256    | 57 |
| 4                               | .66999  | .251    | 1.080   | .237    | 56 |
| 5                               | .67021  | .304    | 1.074   | .217    | 55 |
| 6                               | .043    | .357    | 1.067   | .198    | 54 |
| 7                               | .064    | .410    | 1.061   | .178    | 53 |
| 8                               | .086    | .463    | 1.054   | .159    | 52 |
| 9                               | .107    | .516    | 1.048   | .139    | 51 |
| 10                              | .67129  | .90569  | 1.1041  | .74120  | 50 |
| 11                              | .151    | .621    | 1.1035  | .100    | 49 |
| 12                              | .172    | .674    | 1.1028  | .080    | 48 |
| 13                              | .194    | .727    | 1.1022  | .061    | 47 |
| 14                              | .215    | .781    | 1.1016  | .041    | 46 |
| 15                              | .67237  | .90834  | 1.1009  | .74022  | 45 |
| 16                              | .258    | .887    | 1.1003  | .74002  | 44 |
| 17                              | .280    | .940    | .0996   | .73983  | 43 |
| 18                              | .301    | .90993  | .0990   | .963    | 42 |
| 19                              | .323    | .91046  | .0983   | .944    | 41 |
| 20                              | .67344  | .91099  | 1.0977  | .73924  | 40 |
| 21                              | .366    | .153    | .0971   | .904    | 39 |
| 22                              | .387    | .206    | .0964   | .885    | 38 |
| 23                              | .409    | .259    | .0958   | .865    | 37 |
| 24                              | .430    | .313    | .0951   | .846    | 36 |
| 25                              | .67452  | .91366  | 1.0945  | .73826  | 35 |
| 26                              | .473    | .419    | .0939   | .806    | 34 |
| 27                              | .495    | .473    | .0932   | .787    | 33 |
| 28                              | .516    | .526    | .0926   | .767    | 32 |
| 29                              | .538    | .580    | .0919   | .747    | 31 |
| 30                              | .67559  | .91633  | 1.0913  | .73728  | 30 |
| 31                              | .580    | .687    | .0907   | .708    | 29 |
| 32                              | .602    | .740    | .0900   | .688    | 28 |
| 33                              | .623    | .794    | .0894   | .669    | 27 |
| 34                              | .645    | .847    | .0888   | .649    | 26 |
| 35                              | .67666  | .91901  | 1.0881  | .73629  | 25 |
| 36                              | .688    | .91953  | .0875   | .610    | 24 |
| 37                              | .709    | .92008  | .0869   | .590    | 23 |
| 38                              | .730    | .062    | .0862   | .570    | 22 |
| 39                              | .752    | .116    | .0856   | .551    | 21 |
| 40                              | .67773  | .92170  | 1.0850  | .73531  | 20 |
| 41                              | .795    | .224    | .0843   | .511    | 19 |
| 42                              | .816    | .277    | .0837   | .491    | 18 |
| 43                              | .837    | .331    | .0831   | .472    | 17 |
| 44                              | .859    | .385    | .0824   | .452    | 16 |
| 45                              | .67880  | .92439  | 1.0818  | .73432  | 15 |
| 46                              | .901    | .493    | .0812   | .413    | 14 |
| 47                              | .923    | .547    | .0805   | .393    | 13 |
| 48                              | .944    | .601    | .0799   | .373    | 12 |
| 49                              | .965    | .655    | .0793   | .353    | 11 |
| 50                              | .67987  | .92709  | 1.0786  | .73333  | 10 |
| 51                              | .68008  | .763    | .0780   | .314    | 9  |
| 52                              | .029    | .817    | .0774   | .294    | 8  |
| 53                              | .051    | .872    | .0768   | .274    | 7  |
| 54                              | .072    | .926    | .0761   | .254    | 6  |
| 55                              | .68093  | .92980  | 1.0755  | .73234  | 5  |
| 56                              | .115    | .93034  | .0749   | .215    | 4  |
| 57                              | .136    | .088    | .0742   | .195    | 3  |
| 58                              | .157    | .143    | .0736   | .175    | 2  |
| 59                              | .179    | .197    | .0730   | .155    | 1  |
| 60                              | .68200  | .93252  | 1.0724  | .73135  | 0  |
| N. Cos. N. Cot. N. Tan. N. Sin. |         |         |         |         |    |

|                                 | N. Sin. | N. Tan. | N. Cot. | N. Cos. |    |
|---------------------------------|---------|---------|---------|---------|----|
| 0                               | .68200  | .93252  | 1.0724  | .73135  | 60 |
| 1                               | .221    | .306    | .0717   | .116    | 59 |
| 2                               | .242    | .360    | .0711   | .096    | 58 |
| 3                               | .264    | .415    | .0705   | .076    | 57 |
| 4                               | .285    | .469    | .0699   | .056    | 56 |
| 5                               | .68306  | .93524  | 1.0692  | .73036  | 55 |
| 6                               | .327    | .578    | .0686   | .73016  | 54 |
| 7                               | .349    | .633    | .0680   | .72996  | 53 |
| 8                               | .370    | .688    | .0674   | .976    | 52 |
| 9                               | .391    | .742    | .0668   | .957    | 51 |
| 10                              | .68412  | .93797  | 1.0661  | .72937  | 50 |
| 11                              | .434    | .852    | .0655   | .917    | 49 |
| 12                              | .455    | .906    | .0649   | .897    | 48 |
| 13                              | .476    | .93961  | .0643   | .877    | 47 |
| 14                              | .497    | .94016  | .0637   | .857    | 46 |
| 15                              | .68518  | .94071  | 1.0630  | .72837  | 45 |
| 16                              | .539    | .125    | .0624   | .817    | 44 |
| 17                              | .561    | .180    | .0618   | .797    | 43 |
| 18                              | .582    | .235    | .0612   | .777    | 42 |
| 19                              | .603    | .290    | .0606   | .757    | 41 |
| 20                              | .68624  | .94345  | 1.0599  | .72737  | 40 |
| 21                              | .643    | .400    | .0593   | .717    | 39 |
| 22                              | .666    | .455    | .0587   | .697    | 38 |
| 23                              | .688    | .510    | .0581   | .677    | 37 |
| 24                              | .709    | .565    | .0575   | .657    | 36 |
| 25                              | .68730  | .94620  | 1.0569  | .72637  | 35 |
| 26                              | .751    | .676    | .0562   | .617    | 34 |
| 27                              | .772    | .731    | .0556   | .597    | 33 |
| 28                              | .793    | .786    | .0550   | .577    | 32 |
| 29                              | .814    | .841    | .0544   | .557    | 31 |
| 30                              | .68835  | .94896  | 1.0538  | .72537  | 30 |
| 31                              | .857    | .94952  | .0532   | .517    | 29 |
| 32                              | .878    | .95007  | .0526   | .497    | 28 |
| 33                              | .899    | .062    | .0519   | .477    | 27 |
| 34                              | .920    | .118    | .0513   | .457    | 26 |
| 35                              | .68941  | .95173  | 1.0507  | .72437  | 25 |
| 36                              | .962    | .229    | .0501   | .417    | 24 |
| 37                              | .68983  | .284    | .0495   | .397    | 23 |
| 38                              | .69004  | .340    | .0489   | .377    | 22 |
| 39                              | .025    | .395    | .0483   | .357    | 21 |
| 40                              | .69046  | .95451  | 1.0477  | .72337  | 20 |
| 41                              | .067    | .506    | .0470   | .317    | 19 |
| 42                              | .088    | .562    | .0464   | .297    | 18 |
| 43                              | .109    | .618    | .0458   | .277    | 17 |
| 44                              | .130    | .673    | .0452   | .257    | 16 |
| 45                              | .69151  | .95729  | 1.0446  | .72237  | 15 |
| 46                              | .172    | .785    | .0440   | .216    | 14 |
| 47                              | .193    | .841    | .0434   | .196    | 13 |
| 48                              | .214    | .897    | .0428   | .176    | 12 |
| 49                              | .235    | .95952  | .0422   | .156    | 11 |
| 50                              | .69256  | .96008  | 1.0416  | .72136  | 10 |
| 51                              | .277    | .064    | .0410   | .116    | 9  |
| 52                              | .298    | .120    | .0404   | .095    | 8  |
| 53                              | .319    | .176    | .0398   | .075    | 7  |
| 54                              | .340    | .232    | .0392   | .055    | 6  |
| 55                              | .69361  | .96288  | 1.0385  | .72035  | 5  |
| 56                              | .382    | .344    | .0379   | .72015  | 4  |
| 57                              | .403    | .400    | .0373   | .71995  | 3  |
| 58                              | .424    | .457    | .0367   | .974    | 2  |
| 59                              | .445    | .513    | .0361   | .954    | 1  |
| 60                              | .69466  | .96569  | 1.0355  | .71934  | 0  |
| N. Cos. N. Cot. N. Tan. N. Sin. |         |         |         |         |    |

| '  | N. Sin. | N. Tan. | N. Cot. | N. Cos. | '  |
|----|---------|---------|---------|---------|----|
| 0  | .69466  | -.96569 | 1.0355  | -.71934 | 60 |
| 1  | 487     | 625     | .0349   | 914     | 59 |
| 2  | 508     | 681     | .0343   | 894     | 58 |
| 3  | 529     | 738     | .0337   | 873     | 57 |
| 4  | 549     | 794     | .0331   | 853     | 56 |
| 5  | .69570  | -.96850 | 1.0325  | -.71833 | 55 |
| 6  | 591     | 907     | .0319   | 813     | 54 |
| 7  | 612     | .96963  | .0313   | 792     | 53 |
| 8  | 633     | -.97020 | .0307   | 772     | 52 |
| 9  | 654     | 076     | .0301   | 752     | 51 |
| 10 | .69675  | -.97133 | 1.0295  | -.71732 | 50 |
| 11 | 696     | 189     | .0289   | 711     | 49 |
| 12 | 717     | 246     | .0283   | 691     | 48 |
| 13 | 737     | 302     | .0277   | 671     | 47 |
| 14 | 758     | 359     | .0271   | 650     | 46 |
| 15 | .69779  | -.97416 | 1.0265  | -.71630 | 45 |
| 16 | 800     | 472     | .0259   | 610     | 44 |
| 17 | 821     | 529     | .0253   | 590     | 43 |
| 18 | 842     | 586     | .0247   | 569     | 42 |
| 19 | 862     | 643     | .0241   | 549     | 41 |
| 20 | .69883  | -.97700 | 1.0235  | -.71529 | 40 |
| 21 | 904     | 756     | .0230   | 508     | 39 |
| 22 | 925     | 813     | .0224   | 488     | 38 |
| 23 | 946     | 870     | .0218   | 468     | 37 |
| 24 | 966     | 927     | .0212   | 447     | 36 |
| 25 | .69987  | -.97984 | 1.0206  | -.71427 | 35 |
| 26 | .70008  | -.98041 | .0200   | 407     | 34 |
| 27 | 029     | 098     | .0194   | 386     | 33 |
| 28 | 049     | 155     | .0188   | 366     | 32 |
| 29 | 070     | 213     | .0182   | 345     | 31 |
| 30 | .70091  | -.98270 | 1.0176  | -.71325 | 30 |
| 31 | 112     | 327     | .0170   | 305     | 29 |
| 32 | 132     | 384     | .0164   | 284     | 28 |
| 33 | 153     | 441     | .0158   | 264     | 27 |
| 34 | 174     | 499     | .0152   | 243     | 26 |
| 35 | .70195  | -.98556 | 1.0147  | -.71223 | 25 |
| 36 | 215     | 613     | .0141   | 203     | 24 |
| 37 | 236     | 671     | .0135   | 182     | 23 |
| 38 | 257     | 728     | .0129   | 162     | 22 |
| 39 | 277     | 786     | .0123   | 141     | 21 |
| 40 | .70298  | -.98843 | 1.0117  | -.71121 | 20 |
| 41 | 319     | 901     | .0111   | 100     | 19 |
| 42 | 339     | .98958  | .0105   | 080     | 18 |
| 43 | 360     | .99016  | .0099   | 059     | 17 |
| 44 | 381     | 073     | .0094   | 039     | 16 |
| 45 | .70401  | -.99131 | 1.0088  | -.71019 | 15 |
| 46 | 422     | 189     | .0082   | -.70998 | 14 |
| 47 | 443     | 247     | .0076   | 978     | 13 |
| 48 | 463     | 304     | .0070   | 957     | 12 |
| 49 | 484     | 362     | .0064   | 937     | 11 |
| 50 | .70505  | -.99420 | 1.0058  | -.70916 | 10 |
| 51 | 525     | 478     | .0052   | 896     | 9  |
| 52 | 546     | 536     | .0047   | 875     | 8  |
| 53 | 567     | 594     | .0041   | 855     | 7  |
| 54 | 587     | 652     | .0035   | 834     | 6  |
| 55 | .70608  | -.99710 | 1.0029  | -.70813 | 5  |
| 56 | 628     | 768     | .0023   | 793     | 4  |
| 57 | 649     | 826     | .0017   | 772     | 3  |
| 58 | 670     | 884     | .0012   | 752     | 2  |
| 59 | 690     | .99942  | .0006   | 731     | 1  |
| 60 | .70711  | 1.0000  | 1.0000  | -.70711 | 0  |
|    | N. Cos. | N. Cot. | N. Tan. | N. Sin. | '  |



|  |                                 |
|--|---------------------------------|
| Base of common logarithms                          | = 10.                           |
| Base of Napierian logarithms ( $e$ )               | = 2.71828 18284 59045 23536     |
| Com. Log. $e = M$ (Modulus of Com. Logs.)          | = 0.43429 44819 03251 82765     |
| Nap. Log. 10 = $\frac{1}{M}$                       | = 2.30258 50929 94045 68402     |
| Com. Log. $N = M \times$ Nap. Log. $N$ .           | } where $N$ denotes any number. |
| Nap. Log. $N = \frac{1}{M} \times$ Com. Log. $N$ . |                                 |

| Multiples of M. |              |            | Multiples of $\frac{1}{M}$ . |            |               |
|-----------------|--------------|------------|------------------------------|------------|---------------|
| <b>0</b>        | 0.00000 000  | <b>50</b>  | 21.71472 410                 | <b>0</b>   | 0.00000 000   |
| <b>1</b>        | 0.43429 448  | <b>51</b>  | 22.14901 858                 | <b>1</b>   | 2.30258 509   |
| <b>2</b>        | 0.86858 896  | <b>52</b>  | 22.58331 306                 | <b>2</b>   | 4.60517 019   |
| <b>3</b>        | 1.30288 345  | <b>53</b>  | 23.01760 754                 | <b>3</b>   | 6.90775 528   |
| <b>4</b>        | 1.73717 793  | <b>54</b>  | 23.45190 202                 | <b>4</b>   | 9.21034 037   |
| <b>5</b>        | 2.17147 241  | <b>55</b>  | 23.88619 650                 | <b>5</b>   | 11.51292 546  |
| <b>6</b>        | 2.60576 689  | <b>56</b>  | 24.32049 099                 | <b>6</b>   | 13.81551 056  |
| <b>7</b>        | 3.04006 137  | <b>57</b>  | 24.75478 547                 | <b>7</b>   | 16.11809 565  |
| <b>8</b>        | 3.47435 586  | <b>58</b>  | 25.18907 995                 | <b>8</b>   | 18.42068 074  |
| <b>9</b>        | 3.90865 034  | <b>59</b>  | 25.62337 443                 | <b>9</b>   | 20.72326 584  |
| <b>10</b>       | 4.34294 482  | <b>60</b>  | 26.05766 891                 | <b>10</b>  | 23.02585 093  |
| <b>11</b>       | 4.77723 930  | <b>61</b>  | 26.49196 340                 | <b>11</b>  | 25.32843 602  |
| <b>12</b>       | 5.21153 378  | <b>62</b>  | 26.92625 788                 | <b>12</b>  | 27.63102 112  |
| <b>13</b>       | 5.64582 826  | <b>63</b>  | 27.36055 236                 | <b>13</b>  | 29.93360 621  |
| <b>14</b>       | 6.08012 275  | <b>64</b>  | 27.79484 684                 | <b>14</b>  | 32.23619 130  |
| <b>15</b>       | 6.51441 723  | <b>65</b>  | 28.22914 132                 | <b>15</b>  | 34.53877 639  |
| <b>16</b>       | 6.94871 171  | <b>66</b>  | 28.66343 581                 | <b>16</b>  | 36.84136 149  |
| <b>17</b>       | 7.38300 619  | <b>67</b>  | 29.09773 029                 | <b>17</b>  | 39.14394 658  |
| <b>18</b>       | 7.81730 067  | <b>68</b>  | 29.53202 477                 | <b>18</b>  | 41.44653 167  |
| <b>19</b>       | 8.25159 516  | <b>69</b>  | 29.96631 925                 | <b>19</b>  | 43.74911 677  |
| <b>20</b>       | 8.68588 964  | <b>70</b>  | 30.40061 373                 | <b>20</b>  | 46.05170 186  |
| <b>21</b>       | 9.12018 412  | <b>71</b>  | 30.83490 822                 | <b>21</b>  | 48.35428 695  |
| <b>22</b>       | 9.55447 860  | <b>72</b>  | 31.26920 270                 | <b>22</b>  | 50.65687 205  |
| <b>23</b>       | 9.98877 308  | <b>73</b>  | 31.70349 718                 | <b>23</b>  | 52.95945 714  |
| <b>24</b>       | 10.42306 757 | <b>74</b>  | 32.13779 166                 | <b>24</b>  | 55.26204 223  |
| <b>25</b>       | 10.85736 205 | <b>75</b>  | 32.57208 614                 | <b>25</b>  | 57.56462 732  |
| <b>26</b>       | 11.29165 653 | <b>76</b>  | 33.00638 062                 | <b>26</b>  | 59.86721 242  |
| <b>27</b>       | 11.72595 101 | <b>77</b>  | 33.44067 511                 | <b>27</b>  | 62.16979 751  |
| <b>28</b>       | 12.16024 549 | <b>78</b>  | 33.87496 959                 | <b>28</b>  | 64.47238 260  |
| <b>29</b>       | 12.59453 998 | <b>79</b>  | 34.30926 407                 | <b>29</b>  | 66.77496 770  |
| <b>30</b>       | 13.02883 446 | <b>80</b>  | 34.74355 855                 | <b>30</b>  | 69.07755 279  |
| <b>31</b>       | 13.46312 894 | <b>81</b>  | 35.17785 303                 | <b>31</b>  | 71.38013 788  |
| <b>32</b>       | 13.89742 342 | <b>82</b>  | 35.61214 752                 | <b>32</b>  | 73.68272 298  |
| <b>33</b>       | 14.33171 790 | <b>83</b>  | 36.04644 200                 | <b>33</b>  | 75.98530 807  |
| <b>34</b>       | 14.76601 238 | <b>84</b>  | 36.48073 648                 | <b>34</b>  | 78.28789 316  |
| <b>35</b>       | 15.20030 687 | <b>85</b>  | 36.91503 096                 | <b>35</b>  | 80.59047 825  |
| <b>36</b>       | 15.63460 135 | <b>86</b>  | 37.34932 544                 | <b>36</b>  | 82.89306 335  |
| <b>37</b>       | 16.06889 583 | <b>87</b>  | 37.78361 993                 | <b>37</b>  | 85.19564 844  |
| <b>38</b>       | 16.50319 031 | <b>88</b>  | 38.21791 441                 | <b>38</b>  | 87.49823 353  |
| <b>39</b>       | 16.93748 479 | <b>89</b>  | 38.65220 889                 | <b>39</b>  | 89.80081 863  |
| <b>40</b>       | 17.37177 928 | <b>90</b>  | 39.08650 337                 | <b>40</b>  | 92.10340 372  |
| <b>41</b>       | 17.80607 376 | <b>91</b>  | 39.52079 785                 | <b>41</b>  | 94.40598 881  |
| <b>42</b>       | 18.24036 824 | <b>92</b>  | 39.95509 234                 | <b>42</b>  | 96.70857 391  |
| <b>43</b>       | 18.67466 272 | <b>93</b>  | 40.38938 682                 | <b>43</b>  | 99.01115 900  |
| <b>44</b>       | 19.10895 720 | <b>94</b>  | 40.82368 130                 | <b>44</b>  | 101.31374 409 |
| <b>45</b>       | 19.54325 169 | <b>95</b>  | 41.25797 578                 | <b>45</b>  | 103.61632 918 |
| <b>46</b>       | 19.97754 617 | <b>96</b>  | 41.69227 026                 | <b>46</b>  | 105.91891 428 |
| <b>47</b>       | 20.41184 065 | <b>97</b>  | 42.12656 474                 | <b>47</b>  | 108.22149 937 |
| <b>48</b>       | 20.84613 513 | <b>98</b>  | 42.56085 923                 | <b>48</b>  | 110.52408 446 |
| <b>49</b>       | 21.28042 961 | <b>99</b>  | 42.99515 371                 | <b>49</b>  | 112.82666 956 |
| <b>50</b>       | 21.71472 410 | <b>100</b> | 43.42944 819                 | <b>50</b>  | 115.12925 465 |
|                 |              |            |                              | <b>51</b>  | 117.43183 974 |
|                 |              |            |                              | <b>52</b>  | 119.73442 484 |
|                 |              |            |                              | <b>53</b>  | 122.03700 993 |
|                 |              |            |                              | <b>54</b>  | 124.33959 502 |
|                 |              |            |                              | <b>55</b>  | 126.64218 011 |
|                 |              |            |                              | <b>56</b>  | 128.94476 521 |
|                 |              |            |                              | <b>57</b>  | 131.24735 030 |
|                 |              |            |                              | <b>58</b>  | 133.54993 539 |
|                 |              |            |                              | <b>59</b>  | 135.85252 049 |
|                 |              |            |                              | <b>60</b>  | 138.15510 558 |
|                 |              |            |                              | <b>61</b>  | 140.45769 067 |
|                 |              |            |                              | <b>62</b>  | 142.76027 577 |
|                 |              |            |                              | <b>63</b>  | 145.06286 086 |
|                 |              |            |                              | <b>64</b>  | 147.36544 595 |
|                 |              |            |                              | <b>65</b>  | 149.66803 104 |
|                 |              |            |                              | <b>66</b>  | 151.97061 614 |
|                 |              |            |                              | <b>67</b>  | 154.27320 123 |
|                 |              |            |                              | <b>68</b>  | 156.57578 632 |
|                 |              |            |                              | <b>69</b>  | 158.87837 142 |
|                 |              |            |                              | <b>70</b>  | 161.18095 651 |
|                 |              |            |                              | <b>71</b>  | 163.48354 160 |
|                 |              |            |                              | <b>72</b>  | 165.78612 670 |
|                 |              |            |                              | <b>73</b>  | 168.08871 179 |
|                 |              |            |                              | <b>74</b>  | 170.39129 688 |
|                 |              |            |                              | <b>75</b>  | 172.69388 197 |
|                 |              |            |                              | <b>76</b>  | 174.99646 707 |
|                 |              |            |                              | <b>77</b>  | 177.29905 216 |
|                 |              |            |                              | <b>78</b>  | 179.60163 725 |
|                 |              |            |                              | <b>79</b>  | 181.90422 235 |
|                 |              |            |                              | <b>80</b>  | 184.20680 744 |
|                 |              |            |                              | <b>81</b>  | 186.50939 253 |
|                 |              |            |                              | <b>82</b>  | 188.81197 763 |
|                 |              |            |                              | <b>83</b>  | 191.11456 272 |
|                 |              |            |                              | <b>84</b>  | 193.41714 781 |
|                 |              |            |                              | <b>85</b>  | 195.71973 290 |
|                 |              |            |                              | <b>86</b>  | 198.02231 800 |
|                 |              |            |                              | <b>87</b>  | 200.32490 309 |
|                 |              |            |                              | <b>88</b>  | 202.62748 818 |
|                 |              |            |                              | <b>89</b>  | 204.93007 328 |
|                 |              |            |                              | <b>90</b>  | 207.23265 837 |
|                 |              |            |                              | <b>91</b>  | 209.53524 346 |
|                 |              |            |                              | <b>92</b>  | 211.83782 856 |
|                 |              |            |                              | <b>93</b>  | 214.14041 365 |
|                 |              |            |                              | <b>94</b>  | 216.44299 874 |
|                 |              |            |                              | <b>95</b>  | 218.74558 383 |
|                 |              |            |                              | <b>96</b>  | 221.04816 893 |
|                 |              |            |                              | <b>97</b>  | 223.35075 402 |
|                 |              |            |                              | <b>98</b>  | 225.65333 911 |
|                 |              |            |                              | <b>99</b>  | 227.95592 421 |
|                 |              |            |                              | <b>100</b> | 230.25850 930 |

